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GAI-13: PAD-81-08

REPORT BY THE

Comptroller General

OF THE UNITED STATES

ORIGINAL

COMPLETED

States' Experience With Beverage Container Deposit Laws Shows Positive Benefits

In recent years, several States have enacted laws requiring refundable deposits on beverage containers. Using data based on the experience of four states--Maine, Michigan, Oregon, and Vermont--GAO updated its 1977 estimates of the impact of a nationwide mandatory deposit law.

As in 1977, GAO estimates that litter, solid waste, and energy and raw material use would be reduced. Some industry costs would rise, but deposit-related revenue would also increase.

Reductions in litter and solid waste are fairly certain outcomes of a mandatory deposit law. However, the potential magnitude of other effects--reductions in energy and raw material consumption and increases in industry costs--depends on consumer and industry reaction to the types of containers bought and sold.

PAD-81-08
DECEMBER 11, 1980

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-200893

The Honorable Mark O. Hatfield
United States Senate

The Honorable Bob Packwood
United States Senate

You asked that we update our 1977 study of the effects of a national beverage container deposit law. To do this, we have studied the experiences of Maine and Michigan, both having only recently implemented such a law, and we have examined recent developments in the beverage market nationwide. Using this information, we have revised all the environmental and business effects reported in "Potential Effects of a National Mandatory Deposit on Beverage Containers" (PAD-78-19, December 7, 1977).

Having looked at the beverage container deposit law issue for a second time, and having examined the experience in a number of States, we now conclude that if the Congress passed a national law, the beverage container share of litter and post-consumer solid waste would be greatly reduced. This would happen because consumers would return empty containers at a high rate for their deposit refund.

The reduction in beverage container litter--more than 80 percent by piece count--can be measured by the decrease in litter pick-up costs. Post-consumer solid waste would be reduced approximately 5 percent and would also cost less to pick up and store. Since it is not possible to quantify the esthetic benefits of reducing litter and solid waste, we are not able to compare the value of the benefits of such a law, which would be accompanied by decreases in energy and raw material use, with the increase in consumer costs and possible inconvenience.

Nonetheless, we would like to point out that the burdens to society from beverage container litter and solid waste disposal problems are no less tangible than the costs that the industry claims it would have to pay if it were required to redeem empty deposit containers. Passing a national beverage container deposit law would indeed shift litter and solid waste costs from the public to the private sector. Because the benefits and costs cannot be compared in an exact quantitative way, the Congress must weigh both financial and nonfinancial interests in deciding this issue.

At your request, we did not obtain agency comments. As we arranged with your office, we will distribute this report to interested parties and make other copies available on request.

Comptroller General
of the United States

REPORT BY THE
COMPTROLLER GENERAL
OF THE UNITED STATES

STATES' EXPERIENCE WITH BEVERAGE CONTAINER DEPOSIT LAWS SHOWS POSITIVE BENEFITS

D I G E S T

In the GAO report Potential Effects of a National Mandatory Deposit on Beverage Containers (PAD-78-19, December 7, 1977), GAO estimated the environmental and business effects if the Congress were to pass a law requiring refundable deposits on beer and soft drink containers. At the request of Senators Mark O. Hatfield and Bob Packwood, GAO has brought the 1977 estimates up to date. As requested, we solicited no agency comments.

ESTIMATES IN 1977

In the 1977 report, GAO assumed that a high percentage of beverage containers would be returned to the beverage companies because of a deposit law. This would reduce litter and solid waste. Because the returned containers would probably be reused or recycled, energy and raw materials would also be saved.

Both costs and revenue would increase for the businesses that would have to develop materials handling systems to redeem and transport the empty containers. Costs would go up because of the extra labor and capital needed to set up such a system. Labor and capital costs would also go up if the beverage companies decided to increase the share of refillable bottles in their container mix. Revenue related directly to a national law would increase because some consumers forgo deposits and empty containers that cannot be refilled are sold as scrap. In 1977, GAO estimated that the increased revenue would offset the increased costs attributable to the beverage container law by about $1.0 to $1.3 billion (in 1974 dollars) in the first 3 years.

ESTIMATES IN 1980

The analysis in 1980 has confirmed the results of the 1977 study in a general way.

Tear Sheet. Upon removal, the report cover date should be noted hereon.

Litter and solid waste would decrease because of a national beverage container deposit law. Reusing returned containers by either refilling or recycling would lower energy and raw material use in the beverage industry. Some business costs would rise, and some revenue from recycling and retained deposits would be available to offset cost increases. (pp. 44-45; ch. 7)

The specifics differ somewhat between the two studies. For one, the container mix projected in 1977 in the absence of a national law (the baseline estimate) is incorrect because of the rapid emergence of the plastic soft drink container and the dominance of the aluminum can sooner than was anticipated. This means that the measures related to container types--labor, capital equipment, energy and raw material, and container costs--are also different for the 1977 and 1980 studies in any given year.

In the 1980 study, GAO selected a single container mix to represent conditions under a national law, whereas in the 1977 report GAO used a range of container mixes. This change was possible because of evidence from four States with deposit laws. In the 1980 report, GAO also increased the estimates of the amount of labor needed at the retail sales points to process empty deposit containers. This change was based on the experience in Michigan; it has added about 30,000 jobs to the 1977 employment and about $220 million (in 1974 dollars) to the cost and revenue comparisons for industry. (pp. 19, 39, 52-53)

Beverage container deposit laws are effective in returning containers to centralized points--the beverage wholesaler or manufacturer. Several positive effects result. Beverage container litter is reduced at least 80 percent. Post-consumer solid waste is reduced about 5 percent. Energy and raw material use for the beverage industry is reduced; the amount depends on the kind of containers used under a deposit law. (pp. 40-41; ch. 6)

These positive effects are purchased primarily at the expense of the beverage companies. Because a deposit law in effect requires a system

to transport the empty containers back to the point where the deposit originated, the companies have to invest in trucks, storage space, and employees to operate the expanded system (about 25 percent of the containers now sold are deposit containers). These costs are borne by the companies. GAO's 1980 estimate of the first-year costs for increased capital stock and wages is $2.1 billion (in 1974 dollars). Not all costs would increase, however. If GAO's estimate of a 50 percent refillable container mix under a national law is accurate, the container purchase expense for all beverage companies would decrease about $1.4 billion (in 1974 dollars). This indicates that the net increase in first-year costs would be $0.7 billion. (ch. 7)

In addition, substantial revenues would arise because of a deposit law that could offset some costs at the wholesaler and production levels. One revenue source would be the income that would derive from the sale of recycled material. GAO's estimate of this revenue is $0.3 billion annually (in 1974 dollars). Another revenue source for the industry would be the income from the deposits that are not claimed by the consumers. GAO estimates that 10 percent of all containers sold would not be returned for refund. With a 5 cent deposit, this means that each year about $0.4 billion (in 1974 dollars) would accrue to the companies. (pp. 50-51)

When the estimated cost and revenue changes are compared for the first year under a national beverage container deposit law, there is no net change: the net change in costs is an increase of $0.7 billion and the increase in revenues is also $0.7 billion (in 1974 dollars). This does not mean that consumer prices would be the same as under the no-law conditions. The revenue that could be used to offset costs attributable to the implementation of a deposit law would not accrue to the businesses at the retail level. If beverage distributors did not lower prices to the retailers, the increased handling costs at that level would put upward pressure on consumer prices. (chs. 7-8)

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CHAPTER 1

INTRODUCTION

Senate bill 50, introduced in the 96th Congress and proposing a national beverage container deposit law, would set the national goals of reducing beverage container litter and solid waste, the amount of materials used to package beverages, and energy consumption. The proposed legislation states that a national mandatory deposit law would result in a high level of reuse and recycling of empty beverage containers, the key to achieving its goals. In response to requests from Senator Mark O. Hatfield, Senate Committee on Appropriations, and Senator Bob Packwood, Senate Committee on Commerce, Science, and Transportation, we have revised our 1977 study of the potential effects of a national beverage container deposit law. 1/

In our 1977 report, we assumed that there would indeed be a high level of reuse and recycling of empty beverage containers under a national law. We found that beverage container litter would be reduced approximately 80 percent by piece count, total solid waste by consumers would be reduced 3 to 4 percent by weight, use of raw materials such as iron ore and bauxite would be reduced by 2 to 3 percent of total U.S. demands, and energy use in the beverage industry would be reduced 30 to 40 percent, about 0.2 of 1 percent of total U.S. energy consumption. In 1980, we believe that these changes are still realistic estimates of the potential benefits of a national beverage container deposit law.

In the 1977 report, we also estimated that business costs would increase in some areas but revenue attributable to the law would increase. When summed for all elements in the beverage industry, estimated cost decreases and revenue increases would represent an increase in net revenue, which could be translated into price decreases if the revenue were forgone. In the present review, we have found that retail costs are probably higher than we estimated in 1977 and that, if there were net revenue increases, they would probably be forgone only by means of competitive pressures.

Three levels of activity in the beer industry and two in soft drinks combine to make, move, and sell packaged beverages in the United States today. For beer, the three are set by the 80 breweries, the 4,900 beer wholesalers, and the esti-

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1/"Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977.

mated 200,000 retail sales points. 1/ All would experience some increase in costs under a national beverage container deposit law. All or some of the cost increases could be offset at the brewery and wholesaler level. Revenue would increase because of the change in retained deposits, a switch to refillable containers by the brewery could reduce container purchase costs, and sale of returned nonrefillable containers for recycling would increase revenue.

In the soft drink industry, bottling and wholesaling operations are usually combined within the same firm, of which there are about 2,000. They would experience both increased costs and increased revenue under a national beverage container deposit law. The retailers, who sell most of the soft drinks in the United States and also most of the packaged beer, would face only increased costs. Some states--Maine and Vermont, for example--have required beverage firms to pay the stores 20 percent of the deposit for handling empty containers. Under these conditions, retailers would receive 1 cent per container on a 5 cent deposit to offset their increased costs. The same objective could be reached by raising retail prices 1 cent.

MAJOR AND MINOR ASSUMPTIONS

No one knows what the beverage system would look like under a national mandatory deposit law, largely because there has not been 100 percent deposit coverage for either packaged soft drinks since 1947 or beer since the 1930s. All studies about the effects on a national system, therefore, must begin with both minor and major assumptions about the marketing behavior of all the elements in the beverage industry. We assume, for example, that the beverage producers would react to a law by adjusting their packaging mix in addition to preparing to handle the empty deposit containers. The wholesalers and retailers would also make adjustments to handle the higher number of empty containers passing through their firms. The consumers would look at the products being offered and buy more or less of a beverage because of real and perceived differences in the product caused by the deposit on all containers, whether refillable or nonrefillable.

In the 1977 study, we used existing evidence and expert opinion to form the necessary assumptions about market reaction to a national law. The primary experience at that time

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1/This estimate includes grocery stores, liquor stores, bars selling packaged beer for off-premises consumption, and drug stores.

Table 1

Some Characteristics of Six States
with Beverage Container Deposit Laws

	Implementation date	Population in millions	Population in SMSA a/	Weekly industrial wage
Connecticut	January 1980	3.115	91.6%	$290.37
Iowa	July 1979	2.902	37.1	340.35
Maine	January 1978	1.079	30.5	235.31
Michigan	December 1978	9.207	81.1	367.47
Oregon	October 1972	2.527	57.5	303.68
Vermont	September 1973	0.493	none	242.76

a/Standard Metropolitan Statistical Area.

Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-25, No. 878, March 1980; U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, June 1980.

had been in Oregon and Vermont, both of which had implemented statewide laws. In this 1980 revision, we have looked at the continued experience in these two States and also at Maine and Michigan, which have adopted beverage container deposit laws since 1977. Connecticut and Iowa have adopted similar laws, but they had had less than 1 year of experience with them when we were carrying out our State reviews.

Considered together, the six States contain about 9 percent of the United States population; of this, 6 is in the four States we reviewed in detail--Maine, Michigan, Oregon, and Vermont. The four States are varied in location, urbanization, and industrialization: they range from small Northeastern rural to large Midwestern industrial. Their combined experience helps focus both our major and our minor assumptions about the effects of a national law. Table 1 presents some of the basic information about the States. The population estimates are at midyear 1979; wages are as of April 1980.

OBJECTIVES, SCOPE, AND METHODOLOGY

In this 1980 review, we follow the lead of our 1977 report. As in that report, we present the historical context of individual State beverage container deposit laws, the better to develop our assumptions about a nationwide law. In revising the tables, we have used the 1977 material as a base for the data from subsequent years. (We still report business costs

in 1974 dollars.) This report will be most useful, therefore, if it is read in the complete context of the 1977 report. That study is the framework for our 1980 analysis. Our intent here is not to repeat the background but to show how on-going events have been and may be carried forward.

The present outline differs only slightly from that of 1977. To help show how our assumptions and conclusions derive from actual States' experience, we have moved our descriptions of specific States forward from the appendixes, making them full chapters. Chapter 2 gives our historical description and analysis of Maine and is followed, in chapters 3 and 4, by a similar treatment of Michigan and an explanation of our statistical efforts to measure the changes in beer consumption in 1979 in Michigan in relation to its beverage container deposit law. We show the technical development of the statistical models in appendix II. For our modeling effort for Michigan, we used data on possible explanatory variables for beer consumption. This attempt to separate the effect of legislation from other effects is one of the first in this area.

In chapters 5, 6, and 7, we proceed to develop our new assumptions based on the States' experiences since 1977 and to present our revised estimates of the effect of a law on the beverage system nationwide. Chapter 5 shows our forecasts of sales, container mix, and return rate; we have built primarily on the data in chapter 2 of the 1977 report. Chapter 6 shows our forecasts of the use of raw materials, the production of waste, and the consumption of energy; we have built primarily on the data in chapter 3 of the 1977 report. Chapter 7 shows our forecasts of beverage industry costs; we have built primarily on the data in chapter 4 of the 1977 report.

We gathered our information from various government and private sources within the States, including State liquor control commissions, environmental agencies, transportation departments, and brewers and soft drink manufacturers associations. We studied a variety of published reports as well as estimates made by the U.S. Brewers Association and the National Soft Drink Association. We conducted interviews with and also collected and analyzed statistics and documents from these sources as well as the brewers, soft drink manufacturers, bottlers, distributors, and retailers. We studied material provided to us by a wide range of groups and people, from economists in the universities to local citizens' campaigners for environmental protection. (Complying with Senator Hatfield's request, we have not submitted the report to agencies in the executive branch.) In chapter 8, we present a summary of our assumptions, drawn from all these sources and our own estimates revised from the 1977 report.

CHAPTER 2

MAINE 1978-79

The history of container deposit legislation in Maine goes back as far as the early 1940s. At that time, efforts to legislate returnable bottles were motivated primarily by attempts to protect the State's industry from increasingly powerful out-of-State beverage producers, whose transportation costs would have risen more than those of the local producers under a mandatory deposit law. These early efforts failed, however, and most small brewers and bottlers went out of business in Maine.

Beginning again in 1971, the legislation's supporters began to work in earnest. This time, litter control was the dominant issue. Suffering defeat from sophisticated opposition, the Maine Audubon Society and other environmental preservationists widened their program and refined their strategy. A bill was introduced and reintroduced in the Maine State legislature's biennial sessions in 1971, 1973, 1975, and 1977. Finally, the coalition politics produced a law that was implemented on January 1, 1978. The law was passed by 84 percent of the voters, the largest margin of victory on a referendum question in Maine's history.

The major provisions of Maine's "bottle bill" may be summarized as follows.

--A minimum deposit of 5 cents is required on soft drink and beer containers.

--Brewers and bottlers may continue to use nonrefillable bottles and cans but only if the containers carry a deposit.

--Retailers are entitled to reimbursement of 1 cent for each container they handle.

--Retailers may contract with redemption centers to accept all empties.

--The law bans all detachable tabs on cans and also bans plastic binders for six-packs.

The assumptions we made in the 1977 study were mostly valid for Maine under its new law. Return rates for beverage containers were higher than we had assumed. The change to refillable containers was generally accepted by soft drink bottlers and rejected by malt beverage brewers. The

resulting overall container mixes are within the ranges anticipated in the 1977 study. Beverage sales did not change significantly; beer sales declined somewhat initially but seem to be recovering. Litter and solid waste were reduced. Jobs increased, particularly in distribution and recycling. Recycling increased significantly. There were no indications of health hazards from dirty containers.

SALES

Soft drink sales were not greatly affected by the Maine deposit law, while beer sales did decline temporarily. Losses were particularly noticeable along the border with New Hampshire, which has no deposit legislation. Of the two soft drink bottlers we interviewed, one experienced increasing and the other decreasing sales. The bottler whose sales increased went over completely to refillable containers and claims to be very price competitive. The other bottler shunned refillables because the lack of an extensive product mix in the Maine market made the conversion unprofitable, and the company is not willing to consider plant investment within the State. Officials of this company acknowledge a 17 percent drop in sales from 1977 to 1978.

Beer sales declined 4.4 percent between 1977 and 1978 but grew again in 1979. One distributor stated that only part of the decline was attributable to the deposit law, adding that sales recovered and grew steadily. Maine changed its legal drinking age from 18 to 20 in 1977, which may have reduced beer consumption. Beer consumption for 1976-79 was:

	Gallons
1976	26,292,044
1977	26,315,713
1978	25,168,595
1979	25,617,604

One study concludes that a combination of deposit law and change in drinking age probably disrupts a pattern of beer sales that have increased consistently over as long as a decade. 1/

1/CalPIRG, A California Bottle Bill: The Economic, Resource, and Environmental Implications of Deposit Legislation (Berkley, Calif.: California Public Interest Research Group, January 16, 1980). This group based its assumptions and conclusions on data from Maine, Michigan, Oregon, and Vermont.

CONTAINER MIX

Container mix changed more for soft drinks than for beer in Maine. Most soft drink bottlers changed to refillable containers, which they said were less costly than other containers. On the other hand, most brewers did not change to refillables, largely because breweries are relatively far from the Maine market. Brewers believe it is not economical to change their container mix if they will have to haul empty containers long distances for refilling. A regional brewery has recently started marketing 16 ounce refillable bottles in six-packs.

The U.S. Brewers Association and the Maine Soft Drink Association provided container percentages by volume for before and after the bottle bill was passed and these as well as industry estimates for 1979 are given in table 2. The market share for cans clearly suffered in the beer industry but stayed constant for soft drinks. The soft drink industry switched overwhelmingly to refillables. At present, beer is not filled into plastic containers.

Soft drink distributors point to marked switches to refillable containers. One distributor in Lewiston said that his refillables have gone from 1 to 80 percent since the

Table 2

Maine Container Mix Percentages
by Volume 1977-79

	Before law	After law	
	1977	1978	1979
Soft drinks			
Cans	20%	20%	20%
One-way bottles	80	16	--
Refillable bottles	0	64	70 a/
Plastic	--	--	10
Beer			
Cans	41	32	31
One-way bottles	54	60	61
Refillable bottles	4	8	8

a/May include some one-way bottles.

deposit law, the remaining 20 percent being in cans and plastic. Cott Bottling Company in Portland attributes its climbing sales to having held prices down; Cott claims it was able to do this because it switched to refillable containers. Its container mix has shifted from 25 percent cans and 75 percent one-way glass to 10 percent cans and 90 percent refillable glass. Canada Dry, which bottles in Waltham, Massachusetts, and ships beverages to Maine, decided against refillables. Its mix of 12 percent cans and 88 percent one-way glass has not changed, but Canada Dry has experienced declining sales since enactment of the law. Plastic 2 liter bottles made substantial market penetration throughout Maine in the last 6 months of 1979.

Several beer distributors in Maine told us that the relative shares for beer packages have not changed much from before the deposit law. Mixes varied from 25 to 35 percent cans and 60 to 72 percent one-way glass, with the remainder--3 to 5 percent--in refillables. One southern Maine distributor said that after the law his mix reversed itself from about 60 percent cans and 40 percent one-way glass.

RETURN RATES

Return rates as high as 90 to 95 percent permit bottlers to use the same containers ten to twenty times. According to Maine Citizens for Returnable Containers, the average overall return rate is 93 percent. Cans and bottles appear to be returned at nearly the same rate.

The Cott bottling plant in Portland claims a 99 percent return rate. Other distributors' estimates of their return rates were generally between 90 and 95 percent. Cumberland/York, for example, claimed a 94 to 95 percent return rate on cans and bottles. Canada Dry's company-owned Lewiston distributor has a 92 percent return rate. Cott and Canada Dry differ in that Cott carries a 20 cent deposit on the same container for which Canada Dry charges 5 cents.

LITTER, WASTE, AND RECYCLING

Litter reduction was the focal point of deposit law proponents. According to one Maine recycler, a repeal effort in Maine failed largely because litter had disappeared from highways and school grounds and the cost of cleaning highways had been halved. Some distributors, however, point out that containers are only a part of the overall litter problem and that plastic and noncarbonated beverage containers and paper litter are still around.

Several studies point to the reduction in litter along roads. The Maine Department of Conservation claims that beverage container litter on Maine roadsides has declined 69 to 77 percent since the bottle bill was implemented, while total litter by item count has dropped 34 to 64 percent. Very few containers found on the roadways were deposit containers. If we exclude no-deposit containers from the analysis, the decline in container litter was 96 percent. Another study by the Maine Department of Transportation showed that the overall litter reduction was 15 percent in 1978 and 10 percent in 1979. Combined container litter was down 55 percent in 1978 and 56 percent in 1979.

Maine generates 727,000 tons of solid waste annually. The two major recycling companies in Maine recycle about 6 percent of the total solid waste. 1/ Maine Citizens for Returnable Containers agree with an official of the Maine National Wildlife Federation that the bottle bill has reduced solid waste volume by at least 6 percent, observing that within 4 months of the law's effective date municipal officials noticed a significant decrease in the volume of solid waste going into landfills.

EMPLOYMENT

The consensus among bottlers, distributors, and State officials is that the deposit law has increased the number of jobs in Maine. Interestingly, the gains in recycling jobs have been greater than anticipated. Other new jobs are in production lines, washing and inspection, and distribution. CalPIRG estimates the increase at 626 jobs in Maine, including the new jobs in recycling.

Distributors say generally that jobs have increased from 10 to 40 percent in distribution and warehousing. Some have put on more trucks to accommodate the larger refillable containers and returning empties. One soft drink bottler we interviewed has added jobs in bottle washing and inspecting refillables.

1/Other analyses show similar estimates of solid waste reduction. The CalPIRG study shows that the bottle bill led to a decline in solid waste volume of over 1 million cubic feet--an 84 percent decline in the beverage container portion of solid waste.

The recycling industry has expanded rapidly in Maine because there is now a steady volume of recyclable materials. People concerned about the environment worried initially whether markets could be found for returned containers. Some distributors believed that they would simply move off the roads and into the dumps, where space was dwindling rapidly. One Maine distributor began a recycling operation just after the law became effective that has become one of the largest in Maine. The twenty-seven full-time employees of Maine Beverage Container Service smash or crush every week 40 to 100 tons of glass, 50 tons of cardboard, 50 tons of steel and 32 tons of aluminum cans, and 15 tons of plastic. Distributors who do not crush their own containers store them in trailers that when full are picked up by recyclers and replaced with empty ones. The recycler crushes the glass and flattens and bales the cans for further shipment to container manufacturers. Distributors can often recover the full amount that they pay retailers for handling.

HEALTH

Maine has not recorded any instances of unsanitary conditions attributable to returned containers. According to the Maine Audubon Society, not one health violation citation attributable to the bottle bill has been issued. An official of Maine's Department of Agriculture said that the bottle bill has not changed health conditions and that stores that were clean before the bill are still clean. After 5,029 Department of Agriculture inspections, no retailers were cited for sanitation violations related to the bottle law, nor have any sanitation deficiencies been identified that could be attributed to the law. Maine's Environmental Health Division arrived at the same conclusion after inspecting more than 400 food service establishments.

CHAPTER 3

MICHIGAN 1978-79

Beginning in 1965, container deposit legislation was introduced in the Michigan legislature in every session, but the legislature never came close to passing a beverage container deposit law. Early in 1976, various environmental and conservation groups decided to take the issue to the people, and on November 2, 1976, the proposed law was approved by 64 percent of those who voted. Only 3 of the 83 counties in Michigan disapproved the measure. The proposal became law on December 3, 1976, and went into effect December 3, 1978. According to the State constitution, the law can be amended or repealed only by a vote of the electors or by three-fourths of the members of both houses of the legislature. The main provisions of the Michigan Beverage Container Deposit Law follow.

--The law applies only to carbonated drinks (soft drinks, soda water, and mineral water) and malt drinks (beer and ale) when sold in airtight containers of 1 gallon or less.

--A container that is refillable by more than one manufacturer may be certified by the Liquor Control Commission.

--A retailer is prohibited from selling beverages included under the law without charging a deposit. Certified containers may have a deposit value of not less than 5 cents; noncertified containers may have a deposit value of not less than 10 cents.

--Retailers may not sell beverages in metal containers that have detachable tabs of any kind.

--The retailer must provide a means for customers to redeem the containers at the store. Retailers may redeem containers only of the size, brand, and kind sold by that retailer.

--Containers sold in Michigan must have the refund value and the name of the State marked on them.

--Distributors are required to redeem from retailers the type and size of containers sold by that distributor.

--Violators of this law are subject to a fine of not less than $100 and not more than $1,000 plus court costs for each day that they are in violation of it.

At the end of Michigan's first year under a mandatory beverage deposit system, there is general agreement that beverage sales in 1979 were less than in 1978. Roadside litter, especially the number of discarded beverage containers, has been greatly reduced. Vast amounts of material, especially aluminum and glass, have been recycled. Employment gains in Michigan resulting from the law far outnumber job losses. Soft drink bottlers, brewers, distributors, and retailers have made substantial capital investments to make the system work (estimates are of about $100 million). Companies at all levels in the beverage distribution system are still adjusting their operations to cope with the law. And residents of Michigan favor continuation of the current system.

The public are much concerned over beverage price increases since the effective date of the Michigan law. It appears that increases have been higher than the increases elsewhere in the Nation. Beer prices seem to be getting the most attention, partly because of the loss of sales to States along the southern Michigan border. The Michigan Liquor Control Commission is considering changes to rules so that retailers can advertise beer prices as a means of stimulating competition and, hopefully, lowering prices. A Wayne County grand jury is also investigating beer prices and their relationship to Michigan's deposit law. As of October 1980, the jury had not completed its work.

The Michigan legislature established a Special Joint Committee to study the impact of the deposit law. On December 4, 1979, the Committee issued a progress report on the first year, but it considered this only an interim report. A final report is to be issued by December 31, 1980.

SALES

Soft drink sales decreased by 5 to 10 percent. There are no precise data on the volume of soft drink sales in Michigan, but various sources attribute the diminished sales to a decrease in tourism and to the law itself. The bottlers and retailers incurred additional costs to implement the law. Many of them raised their prices. One bottler indicated it raised wholesale prices three times in 1979 for a total of almost 30 percent. 1/ Other people contend that the higher

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1/This bottler, however, changed its Michigan operation from a warehouse operation (selling directly to the retailers' warehouses) to a traditional soft drink operation with retail contact by route trucks. In addition, it went from 0 to 83 percent refillables.

prices and the inconvenience of returning containers drove some consumers to alternative products, such as Kool-Aid.

Additionally, many retailers reduced the number of brands and variety of containers available in individual stores because of the additional space required to process returned containers. One supermarket chain with eighty-two stores in the Detroit metropolitan area reduced the variety of soft drink items by 24 percent; slow-moving soft drinks lose out for shelf space, and, as a result, some brands are no longer sold at its branches. Several bottlers mentioned that retailers took two additional steps that raised the price of soft drinks to the consumer. First, they raised the margins on soft drinks from around 20 percent to 30 percent. Then they stopped discounting soft drinks to entice customers into the stores.

In 1978, 7,292,333 barrels of beer were sold. In 1979, this number dropped to 7,026,790 barrels, a loss of about 266,000 barrels, or 3.6 percent. Even so, the three Michigan breweries recorded a 1 percent increase in sales within the State. Two breweries located outside Michigan are the largest sellers within Michigan. These also increased their sales. Miller Brewing Company, the biggest seller in Michigan, increased its 1979 regular beer sales by more than 17 percent over 1978, and its Lite beer sales were up by more than 16 percent. Anheuser-Busch increased sales of Michelob and Michelob Light by 10 and 42 percent, respectively.

Many considered Michigan to be a crucial test of mandatory deposit laws because it is populous, urban, and industrialized. The drop in beer sales during the Michigan law's first year should therefore be examined carefully. We have estimated statistically the variables that affected beer sales in Michigan from 1962, and we present a summary of this analysis in chapter 4 of this report. We used four variables--per capita income, beer prices, unemployment, and population--to account for changes in Michigan beer sales.

To analyze beer sales decreases during 1979, the first full deposit law year, we segregated the effect of the Michigan law from the four known variables in beer consumption. The result is that higher prices, attributed by some to costs caused by the law, account for about 40 to 80 percent of the loss in sales between 1978 and 1979. We used another technique--binary variable analysis--to identify other effects of the law, with similar result. The variables included in the models from 1962 to 1978--income, price, unemployment, and population--account for 20 to 60 percent of the lower 1979 beer sales in Michigan.

We did not include tourism as a model variable. Many think that Michigan tourism is correlated positively to beer sales, but we could not get useful data from 1962 to test this hypothesis. In 1979, Michigan State park camping activity was 10 percent lower than in 1978, and attendance at major tourist sites was down 12 percent. Abnormally poor weather was cited as one cause for depressed tourism. Bad weather may also have crimped beer sales for people who were not touring.

CONTAINER MIX

The sales volume of soft drinks and beer by container mix differed greatly between 1978 and 1979. Generally, there was a significant shift by both soft drink bottlers and brewers from cans and one-way glass bottles to refillable glass bottles. Soft drink bottlers also now package more of their products in plastic bottles. At present, beer is not filled into plastic containers. The data on soft drinks in table 3 are estimates provided by five soft drink bottlers whose sales in 1979 represented about one-third of the total soft drink sales in Michigan. The table shows that the soft drink bottlers increased their volume of sales in refillable glass bottles almost threefold, nearly eliminated the use of nonrefillable glass bottles, reduced the use of cans by almost half, and significantly increased the sales volume in plastic bottles (mainly 2 liter containers).

The data on container mix for beer were given to us by the Michigan Liquor Control Commission for beer sold by Michigan brewers in Michigan and for beer shipments into Michigan by out-of-State brewers, and we estimated the mix from this data. Unlike the soft drink market, beer sales in one-way containers rose dramatically.

The shift in container mix for beer was influenced primarily by the market strategies of the various breweries. With a few major exceptions, the breweries adopted a certified or standard refillable bottle that can be used by any brewer adopting that bottle. Under the Michigan law, the breweries are required to impose a deposit of only 5 cents on certified bottles. Noncertified bottles and cans require a 10 cent deposit. Most of the brewers adopted the certified bottle, because they believed sales would be drastically reduced if a 10 cent deposit container was used. The shift to refillable bottles by brewers was not as pronounced as in the soft drink industry, however, because the producers

Table 3

Michigan Container Mix Percentages
by Volume 1978-79

	Before law 1978	After law 1979
Soft drinks		
Cans	30%	18%
One-way bottles	45	2
Refillable bottles	24	66
Plastic	1	14
Beer		
Cans	69	38
One-way bottles	15	30
Refillable bottles	16	32

of Miller and Michelob--two of the best-selling brands in Michigan--decided to continue packaging their beer in their traditional one-way glass containers. They were concerned that by changing the type of container--Miller has the only clear glass bottle and Michelob has a distinctively shaped bottle--they would have lost their marketing image and, eventually, their sales.

RETURN RATES

Soft drink bottlers and beer distributors informed us that the average return rate for containers in Michigan during 1979 exceeded 90 percent. Various sources indicate the low rate of return on plastic bottles is caused by the lower deposit cost--10 or 20 cents, depending on brand--in relation to the price of the beverage in a large container--2 liters of 67.6 fluid ounces. The traditional soft drink bottle and can contain much less--usually between 10 and 16 ounces--and require a 10 cent deposit.

The point in the beverage distribution system at which the deposit originates varies. Soft drink bottlers, who initiate the deposit when they sell their product to the retailer, play the role of both manufacturer and distributor, and, consequently, the empty containers are returned to them.

Table 4

Michigan Return Rates
for Soft Drinks and Beer 1979

	Percent of sales	Return rate
Soft drinks		
Cans	18%	88%
One-way bottles	2	91
Refillable bottles	66	92
Plastic	14	85
Beer		
Cans	37	97
One-way bottles	30	96
Refillable bottles	32	96

Normally, brewers initiate the deposit on refillable beer bottles, and the beer distributors start it on cans and one-way glass bottles. One brewer deviates from this practice. Anheuser-Busch starts the deposit on all its beer containers. In contrast, Miller Brewing Company initiates few deposits, because almost all its beer is sold in cans and one-way glass bottles; distributors of Miller beer start the deposit on these containers.

Both the brewers and the distributors can find it advantageous to initiate the deposit cycle, because not all containers are returned, and unredeemed deposits can be used to increase profits or to offset additional costs emanating from the deposit law. For example, Anheuser-Busch initiates all its bottle and can deposits and, therefore, retains all unclaimed deposit fees. Miller initiates only the refillable bottle deposits; the distributors initiate the deposit on all other containers and, therefore, collect the unredeemed deposits on all but refillables.

The disparity between Anheuser-Busch and Miller distributors widens when we consider that Miller distributors recycle all bottles and cans and receive the scrap revenue to help offset the additional handling costs caused by redeeming containers. Anheuser-Busch distributors also incur additional costs in handling returned containers but initially received no revenue to offset them because the brewery re-

cycled the returned containers. Recognizing the potential competitive disadvantage this creates for its distributors, Anheuser-Busch began late in 1979 to help them offset some of their additional handling costs by paying them 1 cent for each container returned.

LITTER, WASTE, AND RECYCLING

One of the most important goals of the proponents of the Michigan Beverage Container Deposit Law was, of course, to reduce litter and the consumption of natural resources by refilling and recycling containers. Beverage container litter in Michigan fell precipitously, as table 5 shows. In

Table 5

Percentage Changes in Michigan Litter After Deposit Law

	Population exposure	Piece count
Beer and soft drink container litter		
Items	-85.0	-87.4
Square foot	-85.4	--
Cubic foot	-90.0	--
Deposit related litter		
Items	-66.3	-79.6
Square foot	-78.8	--
Cubic foot	-64.5	--
Total litter		
Items	+10.1	+ 5.6
Square foot	+22.6	--
Cubic foot	- 4.3	--

Source: Daniel B. Syrek, Michigan Litter: After (Sacramento: Calif.: The Institute for Applied Research, 1980). Population exposure is a weighting technique in which a piece-count litter rate is given more or less weight according to the estimated percentage of time people spend in a particular area of population (Syrek, p. 13).

addition, several cities have reported solid waste reductions of 6 percent by volume since implementation.

The increase in total litter noted in table 5 occurred despite the large drop in beverage container litter and other litter related to the deposit. Other litter, such as paper and food wrappings, increased enough to offset the decrease. If other litter had not changed between 1978 and 1979, the drop in beverage container litter and litter related to the deposit would have reduced total litter by 21.4 percent.

Since the law was enacted, the container mix of beverage containers in Michigan has shifted from about 80 percent one-way containers to about 54 percent refillable glass containers. In December 1979, a Special Joint Committee of the Michigan legislature found that nearly 100 percent of the one-way beverage bottles and cans were being recycled. It estimated that 72 million cans and 2,000 tons of aluminum and steel were being recycled every month in Michigan and that 250 tons of glass were being delivered daily to the State's only glass plant.

Both Alcoa and Reynolds have established recycling centers in Michigan since the advent of the deposit law. Their recycling operations supply the beer distributor free of charge with a machine that automatically crushes cans and loads the metal into 40-foot trailers, which are also supplied by the recycling company. Fully loaded trailers are picked up by Alcoa or Reynolds and taken to regional centers, where the aluminum and steel are separated and weighed. The distributor is then paid for the scrap metal, about $700 per ton for aluminum and $200 per ton for steel. For distributors who furnish the equipment and transport the containers to the recycling center themselves, the price per ton is greater. The aluminum company then bales and ships the aluminum to one of its reprocessing plants and resells the steel to a steel company for use as scrap. Almost all cans picked up by soft drink bottlers are presently being recycled. Some bottlers have direct arrangements with Alcoa and Reynolds like those of the beer distributors. Other bottlers dispose of their cans through nearby beer distributors, who purchase the empty cans and process them through their recycling systems.

One-way glass bottles are broken or crushed by beer distributors and sold to Owens-Illinois for about $32 per ton. Distributors must arrange for the transportation of the glass to the Owens-Illinois plant in Charlotte, Michigan. Plastic bottles are ground into small pieces by the bottlers and sold as scrap to one of several companies for 2 to 5 cents per pound or $40 to $100 per ton.

It appears that the prices for scrap steel, aluminum, glass, and plastic could provide significant revenue to soft drink bottlers, brewers, and beer distributors. Although no one told us that recycling revenue was high enough to cover all the increased costs caused by the beverage container law, recycling revenue plus retained deposits would seem to for some.

Distributors differ, of course, but for a firm that originates the deposit on one-way containers each returned container is worth between 0.6 of a cent and 1.5 cents. If each container not returned is worth 10 cents, the revenue potential is obviously high. We calculated the potential revenue for such a hypothetical beer wholesaler with about 1.5 million cases a year, having 30 percent refillables, which are returned to the brewery, and a 93 percent return rate. The revenue from recycling would be about $230,000 a year, while retained deposits from cans and one-way bottles would be about $175,000. This works out to about 27 cents a case.

The expense of handling empty containers could be as high as $400,000 a year, but it would probably be less. We estimate that about eleven employees would be needed for the recycling operation, and more warehouse space, recycling equipment, and trucks and drivers would be required. Labor would cost about $200,000 a year. The capital investment would be about $300,000 for the warehouse, $150,000 for the recycling equipment, and $100,000 for the trucks. The amortized capital expense would be around $60,000 a year. This would leave $140,000 a year for pest control, increased fuel, more utilities, and profit.

EMPLOYMENT

Employment increased in Michigan because of the deposit law as indicated by data we obtained from various firms affected by it. We estimate that employment increased by 4,648 jobs. Labor costs consequently increased at all levels in the beverage distribution chain.

Employment gains at the retail level in Michigan were more than twice as high as we would have projected using our 1977 national model. For example, we estimated that retail employment would rise about 30,000 nationwide. The addition of the equivalent of 3,500 full-time retail employees in Michigan, however, indicates more than 80,000 new employees nationwide, inasmuch as the population of Michigan is about 4.2 percent of the United States.

Soft drink bottlers

There are about thirty soft drink bottlers in Michigan, and we contacted five. These represent about one-third of the total Michigan soft drink market. Pepsi-Cola, with the largest share of the market, could not respond to our questionnaire within the time allowed. The five bottlers gained 362 employees, who were paid an average hourly rate of $8.49. Employment increased primarily where bottlers used the refillable bottle process. For example, at Faygo Beverages, the refillable bottle production line requires 24 people, whereas the nonrefillable bottle line requires 11. Additional people were also hired to sort returned bottles and to operate the bottle washers. We projected a total employment gain of about 720 people for all soft drink bottlers in the State of Michigan.

Brewers and beer distributors

Only three breweries are located in Michigan: Carling, Geyer, and Stroh's. Stroh's, which sells about 12 percent of its total production in Michigan, gained 2.6 percent in employment in 1979. Company officials attributed this completely to the container law. A refillable production line is much less labor efficient than a nonrefillable line. At Stroh's, a can line requires 7 people, a nonrefillable bottle line 22, and a refillable bottle line 35. Stroh's gained 38 jobs in 1979, primarily in the washing and refilling of returnable bottles. The average hourly pay was $10.25, including fringe benefits. Basing our figures on this information from Stroh's as well as data we received from the Michigan Liquor Control Commission, we estimate that 68 people were hired by the Michigan brewers as a result of the container deposit law.

We contacted 18 of 300 beer distributors in Michigan. They accounted for roughly 15 percent of the 1979 beer sales and included the larger distributors in the Detroit metropolitan area. We made additional contacts in Michigan, including some near the border. The 18 distributors gained 105 employees in 1979 over 1978, partly because delivering to retailers and picking up empty containers increased in frequency, and this required hiring additional drivers. More people were also hired to sort returnable containers, and some distributors (primarily Miller) hired more people to operate the can and glass crushers. Assuming our sample represents what occurred throughout the State, we project a total employment gain of about 600 people among distributors in 1979.

Retailers

Three major food retailers operating in the Detroit metropolitan area--A&P, Borman Foods (Farmer Jack's), and Chatham--gave us employment information. Kroger's, which also operates a large number of stores in Michigan, was unable to answer within the time allowed, but we did obtain data from Meijer's, which serves a large segment of the western Michigan market. The four retailers operate about 241 stores, for which they hired 2 to 5 part-time employees per store to handle returnable containers. The new employees received, sorted, counted, and packed returnable bottles and cans at an average hourly wage of $4.08. Occasionally, other, higher paid personnel, such as cashiers and assistant store managers, assisted in this work.

We also contacted several of the hundreds of small retailers that handle beer and soft drinks in the Detroit metropolitan area--party stores, pharmacies, small groceries, and convenience stores. All but one had to hire at least one part-time employee to sort, count, and pack returnable containers. We assume, therefore, that each of the thousands of small retail stores throughout the State has hired at least one additional employee, either full-time or part-time, to handle returnable containers.

Large retailers gave us ratios showing the number of returnable containers each new employee processes. From the most conservative ratio--850,000 containers annually--we project an employment increase of 3,500 people for all the retail stores that sell beverages in Michigan. This estimate assumes that no store operates on the honor return system and that no retail store has any slack time to handle returns with existing employees.

Table 6

Michigan Employment Gains and Losses in Soft Drinks and Beer 1979

	Estimate
Soft drink bottlers	720
Brewers	68
Beer distributors	600
Retailers	3,500
Total gain	4 888
Total loss	240
Net gain	4,648

Job losses

The 240 job losses reported consisted of 73 lost when the National Can Company closed its plant in Livonia, Michigan, and 167 lost when employment was reduced at the Owens-Illinois glass plant in Charlotte. There is some question, however, as to whether all these losses are directly attributable to the Michigan law. At the Charlotte glass plant, for example, there was apparently an upsurge in the plant's volume before the law was implemented, causing a temporary increase in employment. According to one source, the current employment level is at about the same level as before passage of the State law. Nevertheless, we assume that these job losses were all directly caused by the Michigan Law.

CAPITAL INVESTMENT AND OTHER COSTS

With the exception of small retailers, firms at all levels of the beverage distribution system incurred capital investment costs to make the mandatory deposit system work. Various industry estimates place these expenditures at about $100 million (or 2 cents invested for each beverage container sold in Michigan in 1979). The amount invested varied. One large grocery store chain, for example, is investing almost $700,000 in remodeled store facilities, container handling carts, refund registers, and new accounting forms. A similar chain store operation said it had invested $2 million. A soft drink bottler spent $8 million to install two new production lines. One beer distributor spent $200,000 for a building to house the recycling operation for glass bottles and cans. We did not validate these costs.

Some capital expenditures were similar at all levels in the distribution system. For example, soft drink bottlers, beer distributors, and some retailers had to acquire additional space to store the empty returned containers. Brewers and soft drink bottlers purchased new production lines and bottle washers. Beer wholesalers bought new and larger trucks to handle the returnables. Retailers invested in shelves, storage bins, and carts.

In addition to labor costs from employment gains and capital investment, various firms identified other costs attributable to the Michigan law, including increased sanitation services to control pests in vehicle and storage areas, higher utility bills for water and fuel to heat the water to wash refillable bottles, and higher bills for diesel fuel and gasoline. Morever, the efficiency of delivery trucks dropped by 20 to 30 percent because of the need to transport

empty containers back to the distributors and, in some cases, back to the breweries. One soft drink bottler estimated that its gasoline consumption in 1979 was more than 385,000 gallons, compared to about 300,000 gallons in 1978. We were unable to evaluate the total impact of these costs, but they are legitimate and do emanate from the law.

CHAPTER 4

MICHIGAN BEER CONSUMPTION AND THE EFFECT OF LEGISLATION IN THREE MODELS

Beer consumption increased steadily in Michigan from 5.22 million barrels in 1962 to 7.29 million barrels in 1978, but it declined to 7.03 million barrels in 1979. This decline might be explained partly by the fall in Michigan's real per capita income or by the increase in the minimum drinking age. On the other hand, higher unemployment might have increased consumption, given that people out of work have more leisure time or experience more stress. Tourism, the weather, and other variables may also affect beer consumption, but we do not have enough data to assess them. We are interested primarily in determining to what extent the decline can be attributed to the State legislation that encouraged the return of beer containers to retail outlets by requiring that deposits be paid.

Michigan's deposit legislation could have affected beer consumption in several ways from the time it became effective in December 1978. Costs that increased to cover increased production, distribution, and handling expenses could have led firms to increase prices, which in turn might have decreased consumption. The container law might also have caused a temporary decrease in beer consumption because of the inconvenience of having to return containers for a refund. The effect of the inconvenience is especially difficult to determine, but we inferred its upper limit by comparing the projection of the law's effect through increased prices with the effect we estimated with a separate technique. We also estimated the effect on beer consumption of new jobs caused by the law, though this proved to be relatively insignificant.

Using statistical techniques, we can compare changes in selected economic and demographic variables over time to changes in beer consumption within the same time, to see if the changes in the variables explain the changes in beer consumption. Using annual data from 1962 to 1978, we developed three statistical models using different combinations of these explanatory variables: beer prices, cost per barrel, per capita income, population, and unemployment. The models give us estimates of the extent to which changes in these economic and demographic elements might have affected Michigan's beer consumption in 1979. To check our estimates, we used the same models but with data from 1962 to 1979, using a binary variable for 1979.

Three models seemed a reasonable number on which to base our estimates. The three we selected met our individual and collective criteria best. We excluded many because of wrong signs for some of the variables. We were looking for equations with good overall fits and good fits for the most recent years. We also wanted equations with variables significant statistically at the 90 percent level of confidence or higher. When the effect of a variable seemed unreasonable, we tried other versions. Most of the models were single equation models, but we also tried to estimate the change in beer consumption by constructing equilibrium supply and demand models. Only one had the correct signs.

We used regression analysis to estimate the coefficients of the factors that affect beer consumption. All the explanatory variables were highly correlated with each other, moving closely in the same or opposite directions. Highly correlated variables may reduce the reliability of their coefficients, making it difficult to estimate the contributions of individual factors. We tried to correct for this problem in model 3.

Because historical retail price data for Michigan for 1962 to 1979 were not available, we assumed that national data paralleled the Michigan series and used the real national retail price index in the demand equations. For the same reason, we used the national beer cost per barrel in the supply equation. We had to estimate the cost series for 1978.

Given wholesale prices in Michigan for 1977-79, we estimated that the 1979 Michigan retail prices increased more than the national retail price. In our estimates, we attributed this difference to the law. As we noted in chapter 3, the industry believes that the law increased production, distribution, and handling costs. Such increases might have led to increased prices. Primarily because of these price or cost increases, we estimate that the legislation was responsible for reducing consumption in 1979 by 117,000 or 124,000 or 206,000 barrels, depending on which of the three models we look at. Table 7 (page 27) summarizes our estimates.

Trying to measure the effect of the container deposit legislation precisely is difficult because of the missing data and also because of statistical problems. In our efforts, we attempted to do more than subjectively attribute the decline in beer consumption to the legislation or simply to factors other than the law. We hope our models will provide a basis for improved future estimates. Overall, the three models explain 1979 beer consumption in Michigan

FIGURE 1

Michigan Beer Consumption 1962-79
(in Millions of Barrels)

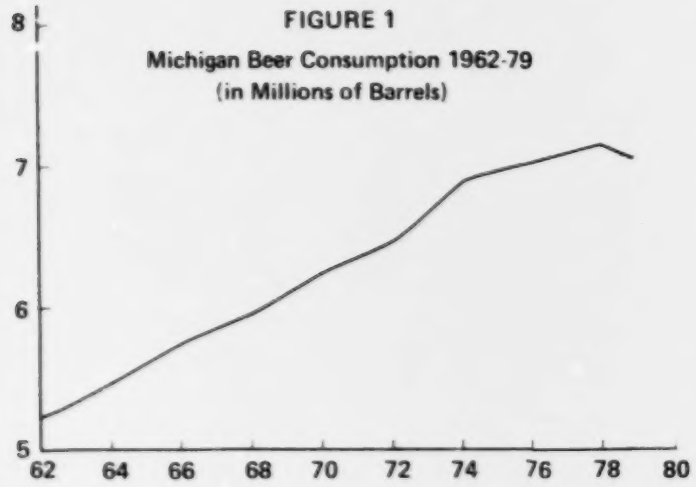


FIGURE 2

Real Beer Price Index 1962-79

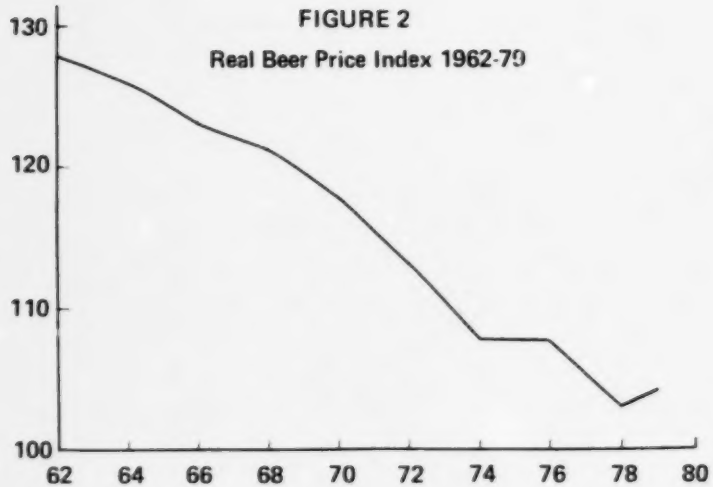


FIGURE 3

Michigan Real Per Capita Income (in Thousands of Dollars)
and Population (in Millions) 1962-79

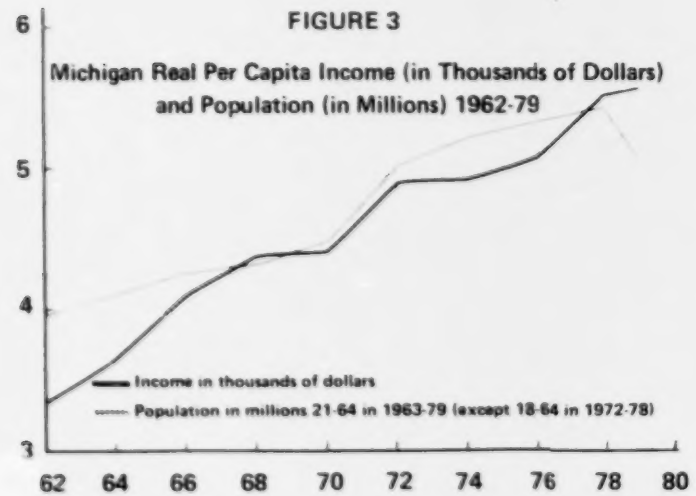
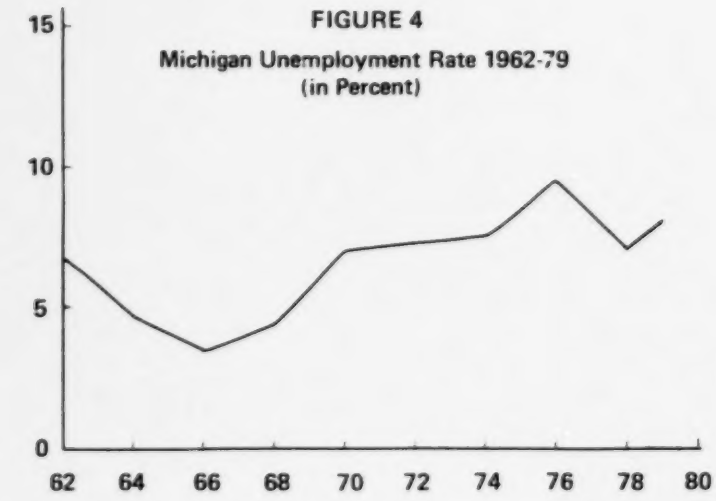


FIGURE 4

Michigan Unemployment Rate 1962-79
(in Percent)



reasonably well, missing the actual decline of 266,000 barrels by a range of 19,000 in the first model to 90,000 in the third. Since we primarily measured the law's effect through increased prices, the effect estimated by our various models (whose variables, in models 1 and 2, are highly correlated) do not seem unreasonable when compared to earlier studies.

Figures 1 and 2 show that the real price of beer is associated negatively with its consumption, so that consumption increases as prices decrease. Figures 3 and 4 show that income, population, and unemployment rate are associated positively with beer consumption, so that as they increase so does beer consumption.

Table 7

Estimated Effects of Change in Beer Consumption in Michigan in 1979 (in Thousands of Barrels)

	Model 1	Model 2	Model 3
From the law a/			
Price	-202	-117	
Cost			-122
Income b/	3		3
Unemployment b/	- 7		- 5
	-206	-117	-124
From other			
Price	- 66	- 32	
Cost			- 33
Income	- 45	42	-126
Unemployment	79		107
Population	- 14	-175	
Past consumption	5		
	- 41	-165	- 52
Total change	-247	-282	-176

a/The binary variable indicates that the total reduction in beer consumption because of the law is 253,000 barrels in model 1, 136,000 barrels in model 2, and 146,000 barrels in model 3. These are larger than the 1979 projection in the table by 47,000, 19,000, and 22,000 barrels, respectively. Using the binary variable, an upper limit approximation of the inconvenience caused by the law is an additional effect.

b/Based on estimates of increased employment in chapter 3.

In our first model, we made Michigan beer consumption a function of Michigan real per capita income, the real national retail beer price index, Michigan population 21 to 64 years of age (but 18 to 64 in 1972-78), and the Michigan unemployment rate. We assumed that the growth in the Michigan price index over the growth in the real national retail price index was caused by the law, and we estimated that Michigan's real retail price was 5.03 index points higher than the national price index for 1979. The model shows that as price increased in 1979 because of the law, beer consumption decreased 202,000 barrels. Also, assuming that the increase in national prices in 1979 reflected price increases in Michigan that were not caused by the law, we estimated a reduction in beer consumption of 55,000 barrels given normal changes in prices without the law. We also estimated another 11,000 barrels reduction in beer consumption caused by changes in past prices.

About half a million people are between 18 and 21 years old in Michigan. Since the average Michigan adult drinks more than 1 barrel (31 gallons) of beer each year, increasing the legal drinking age from 18 to 21 could have limited consumption by more than 500,000 barrels in Michigan in 1979. People younger than 18 in Michigan who had had a greater chance to drink under the old law might have drunk less under the new, and so might people from border States who were younger than 21. Although one recent study has noted that when the legal drinking age was lowered in 1972, beer consumption was not affected, we felt that changes in the legal drinking age should have a greater effect on beer consumption than our first model shows.

In constructing the second model, we eliminated the unemployment rate and real per capita income as explanatory variables and substituted a variable for time to account for their combined effect. Focusing on the relation between prices and consumption, then, we estimated that price increases not caused by the law reduced beer consumption 32,000 barrels. The price increases because of the law reduced beer consumption 117,000 barrels.

Estimating demand without simultaneously estimating supply may lead to erroneous estimates, if in the real world prices and quantities are determined jointly over time. To estimate structural demand and supply functions for beer consumption, we constructed a third, simple equilibrium model. For the demand equation, we made beer consumption a function of real beer prices, the change in real per capita income, and the change in the unemployment rate. We formulated a simple price-dependent supply equation in which the

real national beer price index is a function of the beer supply in Michigan (or the quantity sold) and the real national beer cost (the variable costs of wages, salaries, and material) per barrel, which represents a measure of productivity.

Changes in plant efficiency and multiplant economies of scale have reduced the per barrel cost of beer, although wages and material costs increased. The size of what is a minimum-efficient plant increased because of significant technological improvements in packaging beer, with faster canning and bottling machinery; the introduction of automated brewhouses that can be run by a few attendants; and an innovation in the brewing process that significantly shortens the aging time of beer and therefore reduces the capital costs of brewing. Larger markets also contributed to the increase in minimum-efficient plant size. The historical reduction in the real cost per barrel reflects the upward shift in the supply function that was caused by the improvements in technology and economies of scale in beer production.

Whereas the first two models measure the effect of price on beer consumption, the third measures the effect of costs. In estimating the supply equation, we had to project national beer costs for 1978 because actual data were not available. To get 1979 costs, we assumed that the percentage increase in real national beer costs per barrel in 1979 was the same as the percentage increase in real Michigan retail beer prices in 1979. Applying this percentage increase to the 1978 real cost per barrel, we obtained an estimate of the increased costs for 1979, and this led us to the estimate that beer consumption dropped 155,000 barrels in 1979 as a result of increased costs. We assumed that this reduction in beer production could be allocated between law and non-law reasons in the same proportion as the increase in Michigan prices to the total increase in prices noted in models 1 and 2. This computation resulted in our estimate that beer consumption decreased 122,000 barrels because of the law and 33,000 barrels for reasons not having to do with the law.

Technically more specific descriptions of the construction and interpretation of our models will be found in appendix II.

CHAPTER 5

SALES, CONTAINER MIX, AND RETURN RATE FORECASTS

In this chapter, we have updated the 1977 report tables showing sales, historical and assumed container mix, our modeling effort for the 1981 and 1985 baseline container mix projections, and return rates. We have compared our major assumptions to the experience in four States with mandatory deposits--Maine and Michigan (discussed in chapters 2-4) and Oregon and Vermont. In the 1977 report, we assumed that a national beverage container deposit law had been enacted on January 1, 1977, with implementation on January 1, 1978. In the present report, we assume that a national law was enacted on January 1, 1980, for implementation on January 1, 1981.

In 1975, there were about 100 breweries in the United States. In 1979, there were about 80 breweries and 45 brewing firms. Today, five firms control 75 percent of the beer market, up from almost 70 percent in 1976. The number of soft drink bottlers, in contrast, fell from 2,300 in 1975 to 2,000 in 1979.

Information for 1978 shows that the trend in beer packaging continues to be away from refillable bottles, falling from 15.5 percent in 1975 to 10.8 percent in 1978. The use of cans declined slightly between 1975 and 1978, but one-way bottles increased. Soft drink packaging displayed dramatic shifts as plastic bottles increased and as large one-way glass bottles decreased remarkably, but refillables have remained consistent since 1971.

SALES

In the 1977 report, we explained the need for estimates of beverage sales in the absence of a national beverage container deposit law and for a description of the beverage system under the conditions of a law. In table 8, we have updated tables 1 and 2 of the 1977 report, to show actual percentage of sales of both soft drinks and beer by container type between 1947 and 1978. Table 9 extends the baseline no-law forecasts to 1985 (see page 32).

We emphasize, however, a point we made early in the 1977 report: "The most important point in discussing these systems is that they can be used only to determine relative

Table 8

Soft Drinks and Beer Sales
By 12 Ounce Container Type 1947-78

	1947	1959	1967	1971	1975	1978
Soft drinks						
Cans	0 %	2.5%	22.3%	33.8%	33.0%	43.8%
One-way bottles	0	1.3	12.8	26.9	29.1	10.8
Refillable bottles	100.0	96.1	64.9	39.3	37.9	37.8
Plastic	0	0	0	0	0	7.6
Beer						
Cans	11.0	39.0	44.0	55.6	60.1	59.4
One-way bottles	3.0	8.0	21.4	20.9	24.4	29.8
Refillable bottles	85.9	53.0	34.6	23.5	15.5	10.8

Source: "Potential Effects of a National Mandatory Deposit on Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, tables 1 and 2, as revised in 1980; U.S. Brewers Association, Brewers Almanac (Washington, D.C.: USBA, 1979); National Soft Drink Association.

differences between the two systems." 1/ The reference was to conditions with and without a national beverage container deposit law. The importance of the statement continues, because in the 3 years since the original report, baseline beverage sales have changed enough that the 1985 baseline forecasts are quite different in the present report from what they were in the 1977 report.

Table 9 shows that the overall packaged volume baseline estimates are fairly close, down 2.7 percent overall, with soft drink and beer estimates both down slightly. Beyond this, the other estimates vary widely. The share of the packaged beverage market held by aluminum cans is well up, but steel is expected to fall enough that the overall can share will be down slightly from the 1977 report estimates. In glass bottles, the one-way estimates fall drastically in the soft drink market. This is partly because of the emergence

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1/"Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, p. 10.

Table 9

Baseline 1985 Sales Forecasts for Soft Drinks and Beer (in Billions of 12 Ounce Equivalents)

	1977	1980	Change
Cans	74.1	70.0	- 5.5%
Soft drinks	28.5	31.6	+ 10.9%
Beer	45.6	38.4	- 15.8
Steel	39.2	18.4	- 53.1
Soft drinks	22.8	15.5	- 32.0
Beer	16.4	2.9	- 82.3
Aluminum	34.9	51.7	+ 48.1
Soft drinks	5.7	16.1	+182.5
Beer	29.2	35.6	+ 21.9
One-way bottles	29.6	18.6	- 37.2
Soft drinks	16.8	3.8	- 77.4
Beer	12.8	14.8	+ 15.6
Refillable bottles	27.8	29.0	- 4.3
Soft drinks	26.0	23.1	- 11.2
Beer	1.8	5.9	+227.8
Plastic	0	10.4	------
Soft drinks	0	10.4	
Total packaged	131.5	128.0	- 2.7
Soft drinks	71.3	68.9	- 3.4
Beer	60.2	59.1	- 1.8

Source: "Potential Effects of a National Mandatory Deposit on Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, table 3, as revised in 1980.

of the large plastic bottles but also perhaps partly because it was expected that soft drink firms would increase their use of aluminum cans.

Looking at the metal can share in more detail, we found that the aluminum can has surpassed our estimate of slow dominance in the metal can market. We thought that aluminum

would rise from 19 percent of total packaged volume in 1977 to 27 percent in 1985 and that steel would stay the same--30 percent of total--for the same period. Our new estimates are nearly the reverse, showing 40 percent for aluminum cans and 16 percent for steel by 1985. This is a drastic shift.

All in all, the sales pictures expected for 1985, as viewed first from 1977 and then from 1980, are surprisingly the same--a total of 131.5 billion filled drinks compared to 128.0 billion--but the packaging mix is quite different. One-way glass is down, as seen in 1980, and cans and plastic bottles are up. Updating the 1977 report has made clear, therefore, that changes determined by the market in beverage packaging are difficult to predict and important in and of themselves. If the trends identified between 1977 and 1980 continue, steel can and glass bottle manufacturers will be losing business, while aluminum can and plastic bottle manufacturers will gain. The natural resource requirements for beverage packaging, including energy, will consequently also be different. We believe that changes made by the competitive actions of beverage packaging firms might affect the market more greatly than changes caused by the enactment of a national beverage container deposit law.

In the 1977 report, we assumed that beverage sales under a national law would not differ from the baseline projections. Evidence from the States that we reviewed for the 1980 report, however, indicates that this assumption should be changed somewhat. Maine, Michigan, Oregon, and Vermont all experienced declining or stagnating beer sales in the first year after their respective laws were implemented. In Maine, Oregon, and Vermont, the three States with more than 1 year of experience, however, sales regained their previous growth patterns, as can be seen in table 10 (on the next page). Soft drink sales seem to have exhibited similar patterns, but reliable statewide data are not available.

The question that has not been answered to anyone's satisfaction is whether a beverage container deposit law imparts a dampening effect on sales. We found that the issue is confounded by the fact that in all the States we reviewed some other change in effect in the initial year of the law could also account for a decrease in beer consumption. In Maine, the legal drinking age was raised from 18 to 20. Michigan experienced poor weather, depressed economic conditions, and an increase in drinking age. In Oregon, the 11 ounce stubby beer container replaced the 12 ounce container that had dominated earlier. In Vermont, tourism suffered greatly because of the OPEC oil embargo and poor weather.

Table 10

Per Capita Beer Sales 1947-79
(in Gallons) a/

	Maine	Michigan	Oregon	Vermont	U.S. Total
1947	16.2	26.1	19.7	16.2	18.4
1957	14.2	21.0	13.2	15.7	15.1
1967	17.5	21.0	17.4	20.5	16.7
1972	21.7	22.2	20.9	24.9	19.4
1973	22.8	23.2	20.8	24.0	20.2
1974	23.5	23.3	21.7	23.0	21.1
1975	24.5	23.8	22.1	24.0	21.6
1976	24.4	24.2	23.1	24.6	21.8
1977	24.2	24.7	23.4	24.4	22.7
1978	22.7	24.6	23.7	26.2	23.4
1979	23.4	23.7	24.4	26.8	23.7

a/Underscored data represent the beginning of the law in each State.

Source: Maine, Michigan, Oregon, and Vermont State liquor control commissions statistics; U.S. Brewers Association estimates.

In the 1977 report, we made several attempts to estimate statistically the effect of the Oregon law on beer sales (appendix V, pp. 85-89). We felt that assigning all the sales drop to any State beverage container deposit law was not correct unless all other factors affecting beer sales remained the same. If they changed, estimates would have to include statistical estimates of the effects of the other factors. In the 1980 report, we have made a rigorous attempt for Michigan, as shown in chapter 4 and appendix II.

We conclude from the sales experience in the four States we studied that there might be a transitory effect in the first year of a national mandatory deposit law. We believe it is more than coincidence that sales stagnate, but we cannot attribute this change in sales completely to "bottle bill" laws. Probably some familiarization effect operates after a law's implementation, and, when the new situation has been adjusted to, other variables that affect beverage sales continue to operate as before. Therefore, we assume the 1980 estimates of soft drink and beer sales will hold the same

in 1981. We assume further, however, that sales will resume the predicted growth in 1982 and beyond.

CONTAINER MIX

In the 1977 report, we could not base our assumptions about so important a variable as container mix on evidence suggesting a single value or a narrow range of values. Our solution was to vary values widely enough to cover most situations. This resulted in the Mix I and Mix II assumption shown in table 6 of the 1977 report and given here in table 11 on the next page. In 1980, we have assumed a single value.

Among the States we studied, actual container mix after implementation of a State law varies with the beverage. Soft drinks seem to be characterized heavily by refillable bottles, regardless of the container mix before the law, whereas beer makes a wide range of adjustments to different State laws. Table 12 illustrates this point clearly (see page 37).

Concentrating on refillable bottles, we see that they ranged between 0 and 53 percent of the soft drink container share before States implemented their laws but ranged between 64 and 91 percent in the first year of the law. Oregon and Vermont both now show about 80 percent soft drinks in refillable bottles after several years of experience with the law. Beer refillable share, on the other hand, ranged between 4 and 36 percent before the law and rose to between 8 and 95 percent the first year after. Oregon's first year of experience with more than 90 percent refillable beer bottles has since moderated to about 50 percent, 7 years after the law. In Maine and Vermont, the refillable share is only 8 to 12 percent.

Clearly the beer and soft drink industries react differently. Soft drink firms shift heavily into refillables--the smallest shift was in Oregon from 53 to 78 percent, while the largest switch was in Vermont from 3 to 85 percent. In Michigan beer shifted from 16 to 32 percent, the largest change, and in Maine it shifted from 4 to 8 percent, the smallest.

Taking a simple weighted average for the first year's soft drink refillable share, we find the range is from 64 to 91 percent and the mean is 71 percent. 1/ Substituting the

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1/Weighted by population only. This assumes that per capita soft drink consumption is the same among the four States.

Table 11

Container Mix Assumptions for 1981
in 1977 and 1980 (in Percent) a/

	1977 estimate				1980 estimate	
	Before law 1977	No law 1981	With law 1981 Mix I	With law 1981 Mix II	No law 1981	With law 1981
Cans	48	52	52	20	51	25
One-way bottles	24	24	--	--	19	15
Refillable bottles	27	24	48	80	24	50
Plastic	--	--	--	--	6	10

a/Not all columns add to 100 because of rounding.

Source: "Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, table 6, as revised in 1980.

Table 12

Container Mix Assumptions for Before and After Container Deposit Law in Four States (in Percent)

	Maine a/			Michigan b/		Oregon c/			Vermont d/		
	Before law	After law	1979	Before law	After law	Before law	After law	1979	Before law	After law	1979
Soft drinks											
Cans	20	20	20	44	18	40	9	15	39	13	15
One-way bottles	80	16	--	33	2	7	0	0	58	14	0
Refillable bottles	0	64	70	22	66	53	91	78	3	73	85
Plastic	0	neg	10	1	14	0	0	7	0	0	0
Beer											
Cans	41	32	31	69	38	33	5	29	33	36	34
One-way bottles	55	60	61	15	30	31	neg	21	60	41	54
Refillable bottles	4	8	8	16	32	36	95	50	7	23	12

a/Maine implementation January 1978.
b/Michigan implementation December 1978; 1979 figures same as for "After law."
c/Oregon implementation October 1972.
d/Vermont implementation September 1973. As of January 1, 1977, Vermont law prohibited nonrefillable bottles. Beer continues to be sold in one-way bottles that have been certified as technically refillable five times. One regional brewery actually refills the lighter one-way glass bottle. Because of all this, the division between one-way and refillable bottles in this table is a subjective estimate.

1979 experience of Maine, Oregon, and Vermont, we find the range is less (66 to 85 percent), and the weighted average is about 69 percent. This simple mathematical computation may be a good representation of the soft drink industry's response to a national beverage container deposit law. The service areas limited by franchise are small, offsetting the weight advantage of one-way containers; the soft drink industry overall now uses about 38 percent glass refillable bottles. It does not seem that this would rise to 100 percent in the States with container deposit laws, because cans have about 15 to 23 percent of the market in those States and plastic bottles are rapidly taking over the large container market there. Therefore, settling on a single value assumption for the refillable bottle share of the soft drink industry, we might choose 65 percent as a likely figure. This is within the range suggested by the Mix I and Mix II assumptions in the 1977 report but is nearer to Mix II 80 percent refillables.

Turning to the beer refillables, we found that none of the States exhibited the adjustment pattern that we assumed in the 1977 report, in which, at a minimum, refillable bottles would take over the share previously held by one-way glass bottles. In Michigan, for example, we were told that the share of one-way glass bottles had actually expanded after the law was implemented, partly because a major brewery continued its sales in nonrefillable containers and was capturing an increasing share of the total beer market. In two other States, Maine and Vermont, the packaging mix did not change after the law was implemented. Faced with this behavior, we cannot continue with the assumption we made in the 1977 report about the reaction of brewers and consumers in the beer market to the imposition of a mandatory deposit.

We can separate the four States into two groups. Michigan and Oregon had breweries within the State when the law was implemented, and in both the refillable beer bottle share grew from 100 to 160 percent. Maine and Vermont beer comes from out of State, and the refillable share basically did not change. We can say that, with a national law, there would probably be some switch into refillable bottles, but there is no clear pattern for beer as there is for soft drinks. In fact, the gain in the refillable share in Oregon came as much from cans as from one-way bottles. We calculated the weighted average for beer at 33 percent refillables (weighted by population and per capita consumption). This is about right for an intuitive comparison with soft drinks, but the range of the States' refillable share from 8 to 50 percent indicates that such an estimate is uncertain.

We may use the same procedure for averaging can, one-way glass, and plastic shares. Soft drink cans would fall between

Table 13

Container Mix Estimate for 1981
by Beverage Type

	Soft drinks	Beer	Total
Cans	20%	35%	25%
One-way bottles	0	32	15
Refillable bottles	65	33	50
Plastic	15	0	10

Oregon's 12 percent and Michigan's 22, about 20 percent as weighted average. Beer can share, in contrast, would range from 21 to 37 percent, for a weighted average of 35 percent. These may be good target values for comparison with the refillable bottle, single value shares discussed above.

One-way glass bottles almost disappear in the soft drink market. Only Michigan is reporting any one-way glass sales and at only 2 percent. For beer, one-way sales are still relatively high in Maine and Vermont--61 and 54 percent, respectively--about the same level as before the law. We expect that a national share would be more like the experiences of Michigan and Oregon, where one-way glass share is 30 and 21 percent, respectively. We estimate that one-way glass share would be about 32 percent nationally for beer. We base this as much on the fact that a major brewery did not switch to refillables in either Michigan or Oregon as on the averaging of State shares.

Plastic bottles seem to do well in deposit States where they have been introduced. Used up to now only for soft drinks in 1 liter and 2 liter sizes, they will probably move up from a 4 percent national share in 1978 to about 15 percent in 1981. We base this expectation not on an average but on expert opinion about the plastic container industry.

In summary, we expect that a national mandatory deposit would result in soft drinks being sold mostly in refillable bottles and beer fairly evenly divided between refillables, one-way bottles, and metal cans, primarily aluminum. When we sum these estimates for soft drinks and beer for comparison with our 1977 report, we find refillable glass would be about 50 percent, cans about 25 percent, one-way glass about 15 percent, and plastic about 10 percent (as shown in table 13). Although this has elements of Mix I and Mix II, the change is minimal.

RETURN RATES

We used a model in our 1977 report to estimate national return rates for refillable bottles, and we used the experience in Oregon and Vermont to help calculate return rates on all containers under a national beverage container deposit law. We assumed that refillable bottles would be returned at a minimum rate of 90 percent and that cans would be returned at a minimum rate of 80 percent. We had no assumption for one-way glass and plastic because we did not include them in our Mix I and Mix II figures. For the 1980 report, we have rerun the model to estimate national return rates for refillables, and we have inquired about return rates in Maine, Michigan, Oregon, and Vermont.

Table 14 gives the results of return rate estimates for the stock adjustment model. We are not sure why the model shows that soft drink return rates have been increasing since 1975. We also do not know why the beer refillable bottle return rate continues to fall. About 90 percent of the sales occur where the beer is drunk on the premises, and this market has very high return rates. Because several of the variables we used in the model are estimates, better return rates might be obtained with better estimates of refillable bottle shares, the length of time a refillable bottle stays out in the trade, and the effect of deposit size on return rates. We have not attempted to improve such estimates but have simply put the 1976-78 data into the original model and rerun it.

Table 14

Market Shares for Refillable Bottles and Estimated Return Rates 1947-78

	Soft drinks		Beer	
	Market share	Return rate	Market share	Return rate
1947	100.0%	95.9%	85.9%	96.9%
1963	88.7	93.9	46.0	95.6
1975	37.9	90.5	15.5	92.7
1978	37.8	91.9	10.8	90.4

Source: "Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, table 4, as revised in 1980.

In contrast to the 90 to 92 percent return rates for refillable bottles arrived at by the national model, the bottlers, brewers, and distributors in the States with container deposit laws report return rates for refillable bottles of between 90 and 97 percent. In addition, these same people report return rates for 12 ounce one-way bottles and cans in the same range. Only in the larger sizes, such as quart beer bottles and 26 to 67 ounce soft drink glass and plastic bottles, do the container return rates drop to as low as 85 percent.

We believe that the evidence as reported by the producers and distributors in the States with container deposit laws is consistent enough to conclude that deposit containers are returned at high rates and that the material of the container or its suitability for refilling does not affect the return rate. Based on this, we would continue with our return rate estimate of 90 percent for refillable bottles, but we would also raise the return rate estimate for cans and one-way glass bottles up to 90 percent.

CHAPTER 6

RAW MATERIALS, LITTER AND WASTE, AND ENERGY CONSUMPTION FORECASTS

Changes in the use of raw materials, in litter and solid waste, and in energy consumption resulting from a national beverage container deposit law would be basically the same in 1985 as we estimated in the 1977 report, although the actual numbers will be different. Differences in the numbers are created as much because the predicted sales and container mix for the 1985 baseline conditions have changed as because we have used a single container mix in the 1980 report.

RAW MATERIALS

In the 1977 report, we estimated that 1985 production of steel cans in the absence of a national law would be 39.2 billion cans and that this could drop to 6.6 billion under the Mix II assumption. The reduction could have decreased iron ore consumption in 1985 by 3 million tons if the cans were recycled. Our revised estimates for the 1985 baseline model, without a national law, predict the production of only 18.4 billion steel cans. If a national law were enacted, we estimate a quite small number of steel cans--around 5 billion--unless the steel can is made more recyclable. Table 15 presents these figures. We estimate that only 16 percent of the beverage can market in 1985 will be made of steel.

The reduction in iron ore consumption made possible by recycling steel cans under a national law would be only 1.4 million tons, whereas our estimate in 1977 was 3 million tons, about 2 percent of total 1985 iron ore consumption. Without a national law, the baseline estimates for steel cans drop by more than half under 1980 conditions, which has its own ramifications for the container market.

We estimated that bauxite consumption would fall about 1.4 million tons if the conditions in the 1977 report for Mix II held true (see table 15). We estimate now that the decrease in consumption in 1985 would be 2.3 million tons, although the base would be larger because of the increase expected in the use of aluminum cans.

These decreases in the use of raw materials, especially for bauxite, are fairly certain. Recycling returned metal cans and even one-way glass has occurred in all the States with beverage container deposit laws.

Table 15

Iron and Bauxite Consumption Reduction Assumptions for 1985 for Steel and Aluminum Cans

	1985 estimate in 1977		1985 estimate in 1980	
	No law	With law Mix II	No law	With law
Iron				
Steel cans produced (billions of cans)	39.2	6.6	18.4	5.0
Return rate (percent)	10.0 a/	80.0	10.0 a/	90.0
Iron ore consumption reduced (millions of tons)	--	3.0	--	1.4
Bauxite				
Aluminum cans produced (billions of cans)	34.9	19.7	51.7	27.0
Return rate (percent)	45.0 a/	80.0	45.0 a/	90.0
Bauxite consumption reduced (millions of tons)	--	1.4	--	2.3

a/Voluntary recycling efforts.

Source: "Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, p. 20 and table 7, as revised in 1980.

Table 16

Solid Waste Reduction Assumptions for 1985

	1985 estimate in 1977		1985 estimate in 1980	
	No Law	With law Mix II	No law	With law
Number of containers thrown away (billions)	108.0	15.8	78.9	12.8
Reduction in number	--	85%	--	84%

Source: "Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, table 9, as revised in 1980.

LITTER AND WASTE

In the 1977 report, we estimated an 80 percent reduction in litter by 1985 caused by a national mandatory deposit law. One detailed study for Michigan gives an actual piece count reduction of 85 percent. As a major, statistically sound survey, it should remove all doubts that mandatory deposit laws reduce litter. The study measured population exposure to litter as well as litter by the more traditional piece count, other litter related to the deposit, such as bottle caps and six-pack carriers, and litter by area and volume. 1/

The reduction in the number of beverage containers thrown away in 1985, so we estimated in 1977, was from 108 billion containers to about 16 billion. The same estimate in 1980 is from about 79 billion to about 13 billion. The reductions are nearly the same for both estimates. In the 1977 report, we estimated a 3 to 4 percent reduction in total solid waste by weight. This is borne out by current estimates of about a 6 percent reduction in solid waste volume in Maine and Michigan.

ENERGY

In the 1977 report, we estimated that energy use with the law would be reduced between 32 and 43 percent, or about 0.2

1/Daniel B. Syrek, Michigan Litter: After (Sacramento, Calif.: The Institute for Applied Research, 1980).

of 1 percent of estimated 1985 total United States usage. Our present estimates for 1985 for container mix and the same energy profiles give a 33 percent reduction. We predict that less energy will be used with a mandatory deposit system. To test this, we ran one simulation in which the container mix did not change at all after implementation but returned containers were recycled or refilled. This resulted in energy reductions for metal cans and plastic bottles such that the overall reduction was about 24 percent.

We emphasize in these energy estimates the relative importance of transportation after the container has been filled.

Table 17

Energy Use for Total Beverage System in 1985 (in Trillions of Btu's) a/

	1985 estimate in 1977			1985 estimate in 1980	
	No law	With law Mix I	With law Mix II	No law	With law
Cans					
Steel	106	89	15	57	11
Aluminum	120	86	49	178	64
One-way bottles	96	0	0	62	52
Refillable bottles	41	72	144	36	79
Plastic	--	--	--	18	28
Total	363	247	208	351	234

a/1977 estimated at 131.5 billion 12 ounce fillings; 1980 estimated at 128.0 billion 12 ounce fillings.

Source: "Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, table 10, as revised in 1980.

Table 18

Manufacturing, Filling, and Transport Energy Profiles for Beer for 1985 a/

	Manufacturing	Filling b/	Transport	Total
Aluminum can (0.6 ounce)				
No return	46.3	3.4	0.9	50.6
90 percent return	18.5	3.4	1.0	22.9
Nonrefillable bottle (5.3 ounces)				
No return	23.6	8.3	2.8	34.7
90 percent return	22.6	8.3	3.8	34.7
Refillable 10-trip bottle (9.2 ounces) c/	4.2	7.5	5.8	17.5
Refillable 10-trip bottle (8.3 ounces) d/	3.8	7.5	5.3	16.6

a/In million Btu's per thousand gallons. Fluid capacity is 12 ounces for all weights.

b/Includes secondary packaging.

c/Long neck, or export.

d/Michigan standard select.

Source: Franklin Associates, Energy and Economic Impacts of Mandatory Deposits, Federal Energy Administration, September 1976.

Many people we contacted about the effects of mandatory deposits said that they thought that a container deposit law increases total energy use because of the increased transportation of empty containers from retail collection points to recycling points and decreased load capacity when using refillables. We found this to be a misconception, however. Table 18 compares the energy expended for manufacturing and for distributing filled beverage containers. Figures for the aluminum can, the one-way beer bottle, and the refillable beer bottle demonstrate the actual location of the energy consumption.

Table 18 clearly shows that the long neck refillable beer bottle, when used ten times, requires less total energy use than its competing container types even if they are recycled. This is not because the refillable containers are more attractive in the filling and transport phases (including secondary packaging) but because the energy used to make the bottle is spread over ten trips. The profile for the 8.3 ounce bottle in table 18 is for a refillable bottle introduced in the Michigan market, considerably more compact than the long neck. According to our estimates, using it results in a 5 percent energy saving spread equally between the manufacturing and transportation operations. This container is referred to as the Michigan standard select.

Our energy estimates show that if a beverage firm were to convert from aluminum cans to refillable bottles, the energy used in filling and transporting would rise 200 percent--from 4.3 million Btu's per 1,000 gallons of beverage delivered to 12.8 million for the standard select or 13.3 million for the heavier long neck. The difference of 8.5 or 9.0 million Btu's is split evenly between the increases in secondary packaging and the transportation required for refillable bottles. In contrast, the ten-trip refillable bottle is about five times as efficient in manufacturing as the aluminum can made of 80 percent recycled aluminum. (A 90 percent return rate results in only 80 percent recycled metal because of melt loss.) Therefore, the advantage of the refillable bottle in total energy use is a result of its low energy requirement in manufacturing.

The breakeven point between aluminum and refillable glass would occur when the number of trips that the bottle makes falls low enough to eliminate its manufacturing advantage. The aluminum can is 8.4 million Btu's more efficient on the filled end, the ten-trip refillable bottle 14.7 million Btu's more efficient in production. Therefore, the number of trips

for a refillable bottle would have to fall enough that its manufacturing energy rose to 10.1 million Btu's per 1,000 gallons delivered. This would occur at 3.8 trips or a return rate of 74 percent. 1/

1/Breakeven point is calculated as follows: refillable bottle filling and transportation energy (12.8 million Btu's per 1,000 gallons) minus aluminum can filling energy (4.4) equals aluminum can manufacturing (18.5) minus the result of dividing refillable bottle manufacturing (38.0) by the number of trips (X), or 12.8 - 4.4 = 18.5 - (38.0/X). Thus, 38.0/X = 18.5 - 12.8 + 4.4, or 38.0/X = 9.9. X = 3.8.

CHAPTER 7

INDUSTRIAL COSTS FORECASTS

Firms in the beverage industries would find the cost of doing business different under a national container deposit law for two reasons. Certain changes would be necessary at all levels on the first day of implementation or shortly thereafter. Other changes in marketing strategy might occur, although their timing would be less certain.

Changes would arise on the day of implementation because consumers would begin returning their empty deposit containers almost immediately. At the present time, about 11 percent of packaged beer and 38 percent of packaged soft drinks are in returnable bottles. Under a national law, nine times the present number of empty beer containers and two and a half times the number of empty soft drink containers would work their way back to the wholesaler or to the point of filling--the bottling plant or brewery. The influx of empty containers would require a materials handling system that does not exist today.

At the refund points, the containers would have to be checked in, sorted, and stored, to await being picked up by the distributor. Beer wholesalers, for instance, would pick up the empties from the retailers, return them to the breweries, and destroy deposit containers that are nonrefillable so that they could not find their way back to the retail return point.

This last step is accomplished at present by shredding the cans and breaking the bottles, which are then sold as scrap. Recycling revenue from this process now ranges between 0.6 of a cent and 1.5 cents for each container. We did not estimate recycling revenue in the 1977 report. In estimating it for the 1980 report, we used a composite value of 0.6 of a cent for each recycled container, to keep the cost estimates in 1974 figures.

Other changes under a national law might follow specific decisions by industry to change the container mix. Most analysts assume that both the soft drink and beer industries would change from one-way containers to refillable bottles to some degree. We believe that the number of refillable containers in the combined package mix of soft drinks and beer would double--from 25 percent to 50 percent--under a national law. This would require increasing the capital investment in filling lines as well as labor in beverage production. Distribution costs would increase somewhat, as refillable

Table 19

Changes in Costs and Revenues of Brewers, Bottlers, Distributors, and Retailers Associated with a National Deposit Law (in Millions of 1974 Dollars)

	1977 estimate 3-year changeover			1980 estimate 1-year changeover	
	No law	With law Mix I	With law Mix II	No law	With law
Costs					
Capital stock	$ 668	$ 1,486	$ 3,116	$ 86	$1,292
Wages	8,753	9,746	10,540	3,005	3,878
New containers purchase	14,460	13,332	10,770	5,051	3,630
Beer transportation	1,081	1,118	1,327	380	410
Total	$24,882	$25,682	$25,753	$8,522	$9,210
Change	--	+800	+871	--	+688
Revenues					
Retained deposits	$ 536	$ 2,602	$ 2,299	$ 146	585
Recycling income	--	--	--	--	265
Total	$ 536	$ 2,602	$ 2,299	$ 146	$ 850
Change	--	+2,066	+1,693	--	+704

Source: "Potential Effects of a National Mandatory Deposit on Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, table 12, as revised in 1980.

bottles are bulkier and heavier than one-way containers. Retailers, however, would change little, if any, beyond increasing space and labor, increases that would already be required to handle the greater number of returned containers.

We assume in 1980 that the changeover to our estimated package mix would happen within 1 year of a national law's implementation. In the 1977 report, we estimated costs of a 3-year changeover. Our revised estimates use the same underlying data and analysis. These are shown in table 19. Capital stock changes are presented as though they occur in the changeover period, even though their financial effect on operating budgets is spread over many years.

For the present report, we have changed the presentation of the business data, in addition to making the change from a 3-year to a 1-year period of analysis for the changeover. Table 19 separates the costs that would be affected by the national deposit law--capital stock, wages, new container purchases, and beer transportation--from the increases in revenue that would be directly related to a deposit law--retained deposits and recycling income. If beverage prices did not change and all other costs remained the same, we could compare (or sum, as we did in the 1977 report) the changes in costs and revenue that are directly related to the deposit law. If the costs were greater than the revenues, we could say that net revenue for the industries depicted--breweries and bottlers, wholesalers and retailers--would be lower than the baseline case. If the revenues were greater than the costs, the net revenue would increase.

In our 1980 calculations, as shown in table 19, all but capital stock would continue at about the same level under an equilibrium condition, or what we called in the 1977 report the "ongoing changes." We estimate that the ongoing changes would result in a $600 million decrease in costs each year after the law's implementation and the annual increase in deposit-related revenues would stay at about $700 million. Capital expenditures would be a one-time cost, with only incremental changes to the new capital stock thereafter, similar to the baseline number in the 1980 "no-law" estimate.

Interestingly, the annual figure for container purchases is very large. In 1974 dollars, the cost of 10 and 12 ounce containers ranges from 3 to 10 cents each. About 90 billion of them would be purchased if there were no national law in 1981, but about 63 billion would be purchased with a law, under estimates for 1981. The increase in retained deposits and the advent of recycling income would add about $700 million to firms' incomes, helping some of them offset the increase in costs they would otherwise fully bear.

Table 20

Employment Increase Assumptions for 1981 in 1977 and 1980
(Full-time Equivalents)

	1977 estimate		1980 estimate
	Mix I	Mix II	
Soft drink bottlers	3,500	4,700	5,800
Soft drink distributors	10,100	23,300	18,300
Brewers	700	7,400	2,300
Beer distributors	10,400	37,500	12,700
Retailers	27,700	29,700	57,000
Total	52,400	102,600	96,100

Source: "Potential Effects of a National Mandatory Deposit on Beverage Containers," U.S. General Accounting Office, PAD-78-19, December 7, 1977, appendix III, p. 65, as revised in 1980.

For the 1980 report, we made one major change in the way we analyzed employment. The estimates of retail job increases are greater now. Because of the information developed in Michigan, we now assume that all retail sales points, no matter how small, would use additional help to receive and handle empty deposit containers.

In table 19, it can be seen that the wage bill for the 96,000 extra jobs in the 1980 estimated container mix would be $873 million in 1974 dollars. Had we not changed our method of estimating retail employment increases, the 1980 estimate total would have been about 66,000 jobs, which would cost $653 million. This would have been quite close to the Mix I estimate in the 1977 report, reflecting the relatively minor changes that the beverage industry would make in its operations under a national beverage container deposit law.

The estimates in the 1977 report that 30,700 jobs would be lost in container, metal, and indirect industries under Mix I conditions and that 61,400 jobs would be lost under Mix II remain the range within which the container mix would affect labor, according to our estimates in 1980. For the 1980 report, we also roughly estimate that about 30,000 jobs would be lost in the nonbeverage industries. No jobs would

be lost in the glass industry, because the number of heavier refillable bottles would increase enough in demand to make up for the slight loss in one-way glass sales. Can manufacturers would lose less in the 1980 estimate than under the 1977 Mix II estimate.

We have not re-estimated the macroeconomic model that we used in the 1977 report. This means that we have not traced, for the entire economy, the way that the 1981 reduction in container purchases (from 92 billion to 62 billion) would affect labor. Our 1980 estimate, however, is that there would be about 66,000 more jobs in the first year of implementation of a nationwide law. This is based on our estimate that there would be 96,000 additional jobs in the beverage industry because of the law and 30,000 fewer jobs in the container and related industries because of the change in container mix. Table 20 summarizes our employment increase assumptions.

In the 1977 report, we estimated the cost and revenue changes for beverages sold, and our figures indicated that net revenue would be greater for an average case of either soft drinks or beer under a national law. Many people have interpreted this to mean that prices would be lower. This is not necessarily so. Prices will decrease if the soft drink bottlers and the brewers actually forgo net revenue increases by lowering their prices to wholesalers and retailers and then only if the price decreases are enough to offset the retailers' increased costs.

CHAPTER 8

CONCLUSIONS

After our review of information available primarily from the four States we examined in detail, most of our assumptions in the 1977 report remain basically the same. Table 21 shows some adjustments between the 1977 and the 1980 report for sales, container mix, and return rate. They do not affect the benefits of a national beverage container deposit law, which we still believe would be achieved.

We have changed the sales level assumption, to recognize that beverage sales in Maine, Michigan, Oregon, and Vermont went down during the first year of their laws. We further assume that sales will regain their growth pattern, because this too has been the experience in the three States that have more than 1 year of experience with the law. We are not able to say that the law caused the entire drop in sales in any of the States, because in each there was at least one other contributing factor. We believe that the first year's decrease in sales, whether from a one-time increase in price or an increase in inconvenience or the shock of a new situation, is a transitory effect. After about 1 year, the other influences on beverage sales would resume their effects. The probable decrease in beverage sales coincides with the period of greatest financial outlay, so that the financial performance of some firms in the soft drink and beer industries might suffer during the first year of a national law. We believe, however, that they would adjust to the new situation thereafter and regain their positions.

In this 1980 report, we have focused the container mix on a single value assumption. In the 1977 report, we assumed a range, called Mix I and Mix II. Our revised estimates are close to the Mix I assumption as far as the refillable share of the container market goes, which means that the adjustment by industry to a national law would not be as severe as would be expected under a radical adjustment, such as was envisioned with Mix II. Our revised estimate also recognizes that one-way glass bottles continue to be used for beer in the States with laws and that plastic is making major inroads in soft drink bottling.

Increasing the return rate assumption from 80 percent for cans and 90 percent for refillable bottles to a minimum of 90 percent for all containers would mean a slightly larger reduction in beverage container litter and solid waste than estimated in the 1977 report. This slight improvement in return rates would also affect energy and raw material use.

Table 21

Sales, Container Mix, and Return Rate Assumptions for 1981 in 197[illegible] and 1980 Compared

	Sales		Container mix		Return rate	
	1977	1980	1977	1980	1977	1980
All containers	No change	Reduced in year 1; no change in trend thereafter				
Cans			20-50%	25%	80%	90%
One-way bottles			n.a. a/	15%	n.a.	90%
Refillable bottles			80-48%	50%	90%	90%
Plastic			n.a.	10%	n.a.	90%

a/Not applicable.

The specific net revenue changes to industry under a national law would be within the ranges estimated in the 1977 report (calculated in 1974 dollars) except for retail costs. The experience in large Michigan supermarkets has caused us to increase our estimate of the number of employees required to handle empty containers. Even with the changes in our estimates, however, there seems to be a net increase in revenue when all the net changes for all the firms are summed together. This does not mean that prices would go down or would not go up. We made this point in the 1977 report and emphasize it again here. Of the three levels in the beverage industry that sell filled goods, the retail level has nothing it can offset its increased costs with, but manufacturing and distributing will have both increased costs and increased revenues. Even if net revenue increases at one of these levels, there may be no compelling reason to lower prices.

Several changes would have to take place on the day a national law was scheduled to go into effect. Firms would have to hire more workers, to handle the approximately fourfold increase in returned containers. They would have to buy more transportation equipment, to move the returned containers. They would have to find access to recycling equipment, if the container mix did not shift greatly to refillable containers.

Changes in container mix would be made at the discretion of the beverage firms. We have estimated that the soft drink industry would shift to about 65 percent refillable bottles, more than the roughly 38 percent now. Our best guess is that refillables would account for 33 percent of beer containers, up from 11 percent now.

We are aware that Senate bill 50 in the 96th Congress calls for a 3-year interval between enactment and implementation. Even so, we have not changed our assumption of a 1-year interval, because there seems to be no need for more than a year between enactment and implementation. In the 1977 report, we assumed that industry and consumers would need some time to adjust to the law after implementation. Container mix under a national beverage container deposit law would not experience a radical adjustment. Originally, we selected a period of 3 years from implementation date before the predicted package mix would be in place and equilibrium would be relatively reestablished. We believe now that 1 year after implementation is long enough to recognize the adjustment period.

Appendixes

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APPENDIX I

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United States Senate

COMMITTEE ON APPROPRIATIONS
WASHINGTON, D.C. 20510

January 7, 1980

Mr. Martin J. Fitzgerald
Director
Office of Congressional Relations
General Accounting Office, Room 7023
Washington, D. C. 20548

Dear Mr. Fitzgerald:

In September of 1977, the General Accounting Office published a study which attempted to assess the direct effects of a national beverage container deposit on American industry and the consumer. The final result of that study was very encouraging to those who believe that deposit legislation is an opportunity to live in a more conservative manner, without sacrificing convenience. Within the extremes of container mix studied by the GAO, all the results were, to a greater or lesser extent, encouraging. The single disadvantage to the GAO study was the fact that no highly urbanized state had passed container deposit legislation and, thus, no concrete information existed on which to base conclusions for the nation as a whole. Industry opponents to beverage container legislation immediately seized upon that weakness to discount all the statistics, inferences and conclusions drawn by that study.

Since that study was completed, the state of Michigan has passed beverage container legislation. Enacted in January, 1979, the Michigan law has been in effect for a little over a year. With a full year to acclimate themselves to the new situation, it would seem that both industry and consumers should have, by now, reached an accommodation and made some conclusions about whether and how the Michigan deposit legislation works.

For that reason, I would like to request that the GAO revise its 1977 study with an addendum based upon information gathered in Michigan. Financed by an annual budget of approximately $20 million, industry efforts to oppose this concept are consistently timely and well organized. Thus, it is essential that in order to present clearly the merits of deposit legislation, our information be trustworthy, objective and up-to-date.

Since the GAO generally produces reports with all of those attributes, I think a GAO revision of the 1977 report would be extremely valuable to the Congress. In anticipation of making this request, I asked my staff to contact one of your staff, Mr. Lamarr White, and learn how long the study would take and whether he could obtain reliable results in a relatively short time. Mr. White speculated that a reliable study might be conducted within three months.

Thank you very much for giving your attention to this request. I will await a reply at your earliest convenience.

Kind regards.

Sincerely,

Mark O. Hatfield
United States Senator

MOH:tms

On January 28, 1980, the Senate Committee on Commerce, Science, and Transportation asked GAO to testify before it on the results of the study requested in this letter by Senator Hatfield. The hearings were subsequently canceled, but Senator Bob Packwood, ranking minority member on the Committee, asked to be associated with the request to revise our 1977 study. It is for this reason that we refer in chapter 1 to both Senators as having requested the present report.

APPENDIX II

MICHIGAN BEER CONSUMPTION MODELS: CONSTRUCTION AND INTERPRETATION

MODEL 1

In model 1, beer consumption is a function of Michigan real per capita income, the real national retail beer price index, Michigan population 21 to 64 years of age (but 18 to 64 in 1972-78), and the Michigan unemployment rate. Using annual data from 1962 to 1978, we obtained a good overall fit, the equation explaining 99 percent of the variation in beer consumption. We estimated this equation a second time with a procedure that corrects for second-order serial correlation. This improved the fit for 1978 and 1979 as forecasted (the most important years of our study), while maintaining the same high overall fit.

All the independent variables are highly correlated with each other, or intercorrelated. While the coefficients have the correct signs, high intercorrelation may make it difficult to distinguish the individual contribution of each variable to beer consumption. When they are used alone in the regression equation, each is statistically significant at the 99 percent level of confidence. Also, individually, except for the unemployment rate, they explain at least 90 percent of the variation in beer consumption. When they are used together, only the unemployment rate and price variables are statistically significant at the 95 percent level of confidence. Income is significant at only the 80 percent level of confidence.

It is important to illustrate how we estimated from this model the various effects that contributed to the change in 1979 beer consumption. The following short version of the model shows the price terms we used to calculate the effect of price changes on 1979 beer consumption if everything else remains the same. The change in beer consumption in million barrels equals -.04010 (times the change in the 1978-79 price index) minus .04010 (times -.1376 multiplied by the change in the 1977-78 price index) minus .04010 (times -.0276 multiplied by the change in the 1976-77 price index).

We assumed that the growth in the Michigan price index over the growth in the real national beer price index was caused by the law. We developed this assumption in the following way. By comparing wholesale prices for the last 3 years in Michigan with the national retail price index, and adding 3 percent to the wholesale prices to reflect retail prices, we estimated that Michigan's retail price was 5.03 index points higher than the national price index for 1979.

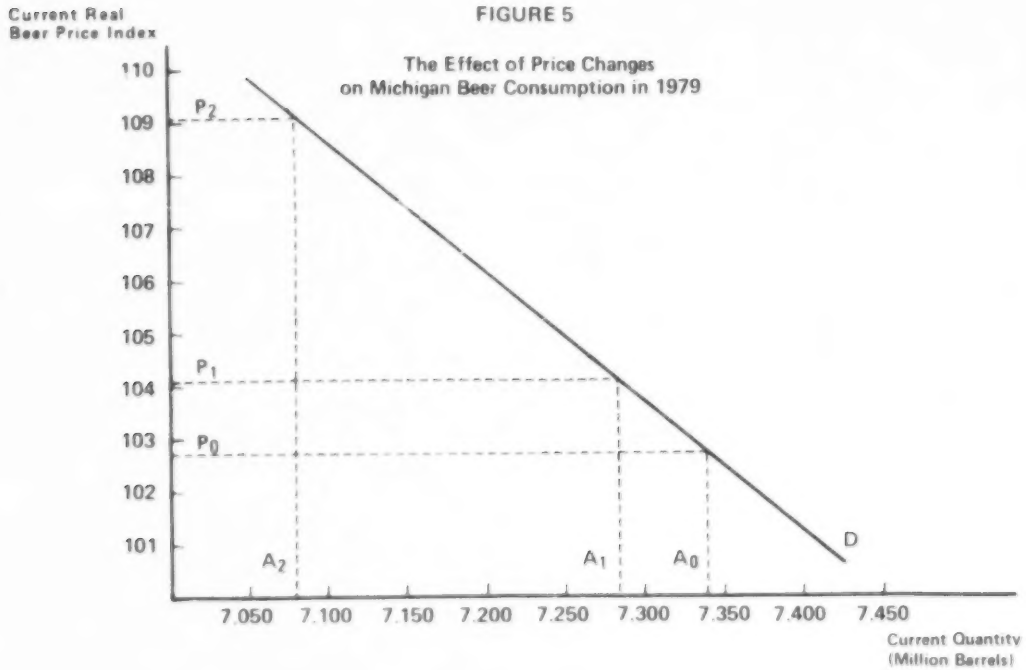
By multiplying the coefficient of the price term (-.0410) by 5.03, we estimated that price changes caused by the law effectively reduced beer consumption 202,000 barrels.

Comparing model 1 with earlier studies leads us to believe that it minimizes potential problems from the high correlation of price with the other independent variables--income, population, and unemployment. The model implies that the price elasticity for beer consumption is 0.6 for 1978, which is negative and inelastic (less than 1). For example, if prices increased by 10 percent, beer consumption would decrease by 6 percent. This accords with earlier studies that show negative price elasticities ranging from 0.6 to 1.1, primarily 0.7 to 0.9.

We assumed that the increase in national prices in 1979 reflected price increases in Michigan that were not caused by the law. Multiplying the change of 1.368 in the national price index in 1979 by the coefficient of the price term (-.04010), we estimated a reduction of 55,000 barrels in beer consumption that was not caused by the law. Changes in the price index of -1.182 and -4.290 for lagged values brought

FIGURE 5

The Effect of Price Changes on Michigan Beer Consumption in 1979



into the equation by the autocorrelation correction technique gave us an estimate of a reduction of 11,000 barrels in beer consumption because of changes in earlier prices. This brought the total reduction in beer consumption because of current and earlier price increases not caused by the law to 66,000 barrels.

Figure 5 illustrates the effect of current price changes on beer consumption in 1979. D is the demand function. If everything else remained the same, the normal increase in current price (not caused by the law) from P_0 to P_1 (1.368 index points) caused an estimated decrease, from A_0 to A_1, of 55,000 barrels in beer consumption. The price increase from P_1 to P_2 (5.03 index points) because of the law decreased beer consumption from A_1 to A_2, an estimated 202,000 barrels.

MODEL 2

For model 2, we eliminated the unemployment rate and real per capita income as explanatory variables and substituted the square root of time to measure their combined effect. Population has a higher effect in model 2 than in model 1, but the independent variables are still highly correlated, possibly still affecting the estimates of the regression coefficients. Of the various ways we tried to model a higher population effect, we chose this because it gave us the best fit overall as well as the best fit for recent years. The model explains 99 percent of the variation in beer consumption. The coefficient of the square root of time is statistically significant at the 99 percent level of confidence. The population variable is statistically significant at 90 percent. The price coefficient is statistically significant at 80 percent, not quite meeting our standards.

To illustrate how the decrease in beer consumption is calculated in this model, we focus again on the effect of changes in price. The price effect on beer consumption in 1979 is obtained by multiplying the change in the price index by the price coefficient. The price increase not caused by the law was 1.368 index points, giving us an estimate that beer consumption was reduced 32,000 barrels. The price increase caused by the law was 5.03 index points (as in model 1), giving us an estimate that beer consumption was reduced 117,000 barrels.

In this model, the negative elasticity of consumption with respect to price is also inelastic, as was generally found in earlier studies. At 0.3, however, it is lower than others because of the population and the time variable. A graph showing the effect of the changes in price for this

model would be identical to figure 5 except that the numbers would change.

MODEL 3

To estimate structural demand and supply functions for beer consumption, we specified a simple equilibrium model, consisting of two behavioral equations and an identity, for the years 1962-78. We tried various combinations of both absolute values and year-to-year changes in values in various regressions. Using changes is one way to correct for collinear independent variables, but we found only one specification that gave us correct signs for the structural supply and demand equations in both the projection and the binary variable approaches.

In our demand equation, beer consumption was a function of real national retail beer prices, the change in Michigan real per capita income, and the change in Michigan's unemployment rate. To simplify our analysis, we formulated a simple price-dependent supply equation in which the real national beer price index is a function of the beer supply (quantity sold) in Michigan and the real national beer cost (the variable costs of wages, salaries, and material) per barrel, which represents a measure of productivity. A historical reduction in the real cost per barrel reflects an upward shift in the supply function that was caused by improvements in technology and economies of scale in beer production.

We used the two-stage least squares estimating technique. In the first stage, we estimated quantity as a function of all the explanatory variables in the model except price, and then we estimated price as a function of all the explanatory variables in the model except beer consumption. These are called the reduced form quantity and price equations (equations 3a and 3b). In the second stage, we used the estimated values of price in the demand equation and quantity in the supply equation as independent variables along with the other appropriate explanatory variables (equations 3c and 3d).

Beer cost per barrel was highly correlated with beer consumption, however. To avoid the wrong signs on the coefficients, we divided both sides of the structural supply equation by beer costs per barrel to obtain the structural supply equation for estimating purposes. The structural supply function explains about 91 percent of the variation in the real beer price index. The structural demand equation explains about 98 percent of the variation in beer consumption in Michigan. All coefficients in both functions are significant at least at the 90 percent level of confidence.

APPENDIX II

Since we are interested in the equilibrium equation for estimating beer consumption in 1979, we derived it by substituting the structural supply function into the structural demand function and obtained the following equation: Michigan beer consumption (in millions of barrels) = 9.533 - 0.1723 (times the real national beer cost per barrel) + 0.004 (times the change in Michigan real per capita income) + 0.0463 (times the change in Michigan unemployment rate).

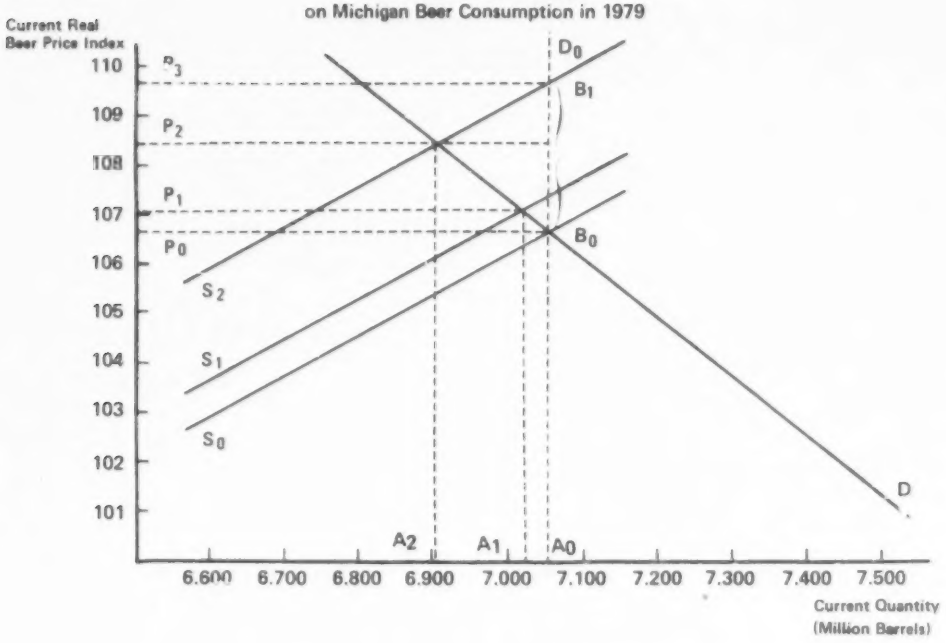
Models 1 and 2 measure the price effect. Model 3 measures the cost effect, because the price does not appear in the equilibrium equation. We had to project national beer costs for 1978 because the data were not available. We regressed beer costs as a function of the two prior costs and time for 1978. To get 1979 costs, we assumed that the percentage increase in real national beer costs per barrel in 1979 was the same as the percentage increase in real Michigan retail beer prices in 1979. Applying this percentage increase to the 1978 real cost per barrel, we obtained an estimate of the increased costs for 1979. Multiplying the increased costs by the coefficient of the cost term in the equilibrium equation, we obtained an estimate of reduction in beer consumption of 155,000 barrels in 1979.

Because of the way the model was specified and estimated, the price effects through costs are not contaminated by intercorrelated variables. Moreover, the negative price elasticity implied in this equilibrium model is 0.7, well in line with earlier studies. Therefore, our estimate of the reduction in beer consumption caused by price increases that were, in turn, caused by cost increases seems reasonable. We attributed this reduction of 155,000 barrels to total increased prices in 1979 in the same proportion as prices increased in 1979 because of the law. This provided the estimate that 122,000 fewer barrels were consumed in 1979 because of costs that increased because of the law. We attributed the remaining 33,000 barrels in the overall reduction to costs that increased but not because of the law.

These effects of the law are interpreted in figure 6 on the next page. If everything else remains the same, the normal cost effect (the effect of costs not caused by the law) is caused by the shift in the supply function from S_0 to S_1 and is shown by the differences between the equilibrium quantities A_0 and A_1. It represents a reduction of 33,000 barrels. The reduction in Michigan beer consumption because of the law is caused by the shift in the supply function from S_1 to S_2 and is shown by the difference between the equilibrium quantities A_1 and A_2. This represents a reduction of 122,000 barrels caused by an increase in the costs of running the new system because of the law.

FIGURE 6

The Effect of Cost Changes
on Michigan Beer Consumption in 1979



The estimated price increases implied by the shift in the supply curve from P_0 to P_2 are not the same as in models 1 and 2 for several reasons. For one, P_0, the estimated price for 1978 (106.6), is higher than the actual price for 1978 (102.7), used in the other models. For another, the producers are sharing part of the increased costs. For example, if the demand curve had been perfectly inelastic (as shown by A_0D_0), then consumers would have paid P_0P_3, which is equal to the full increased costs B_0B_1 in terms of the price index. However, this model implies that, because the demand curve (D) is not perfectly inelastic, the consumers pay only part of the increased costs, or P_0P_2.

Table 22 on the next page and the accompanying notes show details of the elements of our equations and their results for all three models.

APPENDIX II

Table 22

Estimated Regression Equation Results

	Single equation models		Equilibrium model			
Equation	1	2	3a	3b	3c	3d
Constant	8.8740 (3.004)	6.3097 (2.554)	9.5675 (28.09)	76.6384 (16.12)	16.0332 (37.091)	
Dependent variable	a	a	a	b	a	b
Independent variables						
Real Michigan per capita income (1972 dollars)	0.00035 (1.759)					
Real national retail beer price index	-0.0401 (2.465)	-0.02329 (-1.622)			-0.0844 (-23.01)	
Michigan population age 21-64 (18-64 in 1972-1978) (millions)	0.0273 (0.1468)	0.3585 (2.158)				
Michigan unemployment rate	0.0647 (4.534)					
Square root of time		0.3468 (4.569)				
Change in Michigan real per capita income (1972 dollars)			0.0006 (0.915)	-0.0002 (-0.022)	0.0006 (1.918)	
Change in Michigan unemployment rate			0.0517 (0.840)	0.3105 (0.361)	0.0779 (2.735)	
Real national beer cost per barrel (1972 dollars)			-0.1762 (-10.66)	2.0890 (9.051)		3.4353 (14.49)
Michigan beer consumption (million barrels)						8.0817 (12.60)
$\bar{R}^2$	.99	.99	.88	.84	.98	.91
D.W.	1.92	2.19	0.75	0.77	1.55	0.80

NOTES TO TABLE 22

The numbers in parentheses are t values.

The constant is statistically significant at the 95 percent level of confidence or greater for all equations.

The dependent variables are (a) beer consumption in Michigan in millions of barrels in equations 1, 2, 3a, and 3c and (b) the deflated beer price index in equations 3b and 3d.

Independent variables	Statistical significance (percent)	Model
Real Michigan per capita income	80+	1
Real national retail beer price index	95+	1, 3c
	80+	2
Michigan population	90+	2
Michigan unemployment rate	95+	1
Square root of time	95+	2
Change in real Michigan per capita income	90+	3c
Change in Michigan unemployment rate	95+	3c
Real national beer cost per barrel	95+	3a, 3b, 3d
Michigan beer consumption	95+	3d

The single equation in model 1 is based on a second-order serial correlation adjustment. To transform the data, we use the following equation: $\epsilon_t = 0.137564\ \epsilon_{t-1} + 0.0276307\ \epsilon_{t-2}$, where the t values are 0.3264 and 0.06492, respectively.

The constant term in model 3d was estimated from the following equation: price/cost per barrel = $\beta_0 + \beta_1$ (consumption/cost per barrel). After estimating, it was multiplied by cost per barrel, resulting in no constant term.

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